TECHNICAL MANUAL

MAINTENANCE INSTRUCTIONS

DEPOT

INTRODUCTION AND GENERAL INFORMATION

AIRCRAFT ENGINE
USAF MODEL
F100-PW-229

PRATT & WHITNEY
LARGE MILITARY ENGINES
UNITED TECHNOLOGIES CORPORATION
F33657-84-C-2014
F41608-94-D-0816

THIS PUBLICATION IS ONE OF A SET OF TWELVE MANUALS. THE COMPLETE SET, CONSISTING OF T.O. 2J-F100-53-1 THROUGH T.O. 2J-F100-53-11, AND T.O. 2J-F100-11-2, IS REQUIRED FOR DEPOT MAINTENANCE.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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RECORD OF CHANGES

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Change 3	15 May 92	Change 18	15 May 96
Change 4	15 Aug 92	Change 19	15 Aug 96
Change 5	15 Nov 92	Change 20	15 Nov 96
Change 6	15 Feb 93	Change 21	15 Feb 97
Change 7	15 May 93	Change 22	15 May 97
Change 8	15 Aug 93	Change 23	15 Aug 97
Change 9	15 Nov 93	Change 24	15 Nov 97
Change 10	15 Feb 94	Change 25	15 Feb 98
Change 11	15 May 94	Change 26	15 Aug 98
Change 12	15 Nov 94	Change 27	15 Nov 98
Change 13	15 Feb 95	Change 28	15 Feb 99
Change 14	15 May 95	Change 29	15 May 99

TOTAL NUMBER OF PAGES IN THIS MANUAL IS 1470

LIST OF EFFECTIVE FRONT MATTER PAGES

PAGE NO.	CHANGE NO.
Title	29
A - C	29
a	22
b Blank	22
S-1	13
S-2	22
S-3	13
S-4	16
S-5	13
S-6 Blank	13

NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES

NOTE

Only those work packages (WPs) and subordinate work packages (SWPs) assigned to this manual are listed in this index.

Insert Change No. 29 WPs and SWPs, dated 15 May 1999. Dispose of superseded WPs and SWPs. If changed pages are issued to a WP or SWP, insert the changed pages in the applicable WP or SWP. The portion of the text affected in a changed WP or SWP is indicated by change bars in the outer margin of each column of text. Changes to illustrations are indicated by pointing hands or change bars, as applicable. Changes to wiring diagrams are indicated by shaded areas.

WP/SWP Number	*CHANGE NO.
001 00	29
002 00	23
003 00	28
004 00	28
005 00	1
006 00	21

NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES (Continued)

NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES (Continued)

WP/SWP Number	*CHANGE NO.
092 18	0
092 19	0
092 20	0
092 21	0
092 22	0
092 23	0
092 24	0
092 25	0
092 26	0
092 27	0
092 28	0
092 29	0
093 00	0
093 01	0
093 02	0
093 03	0
093 04	0
093 05	0
093 06	0
094 00	0
094 01	0
094 02	0
094 03	0
095 00	0
095 01	0
095 02	0
096 00	19
096 01	0
096 02	19
096 03	19
096 04	19
096 05	19
096 06	19
097 00	0
097 01	0
097 02	0
097 03	0
097 04	0
097 05	0
097 06	0
097 07	0
097 08	0
097 09	0
097 10	0
097 11	0
097 12	0
098 00	21
098 02	0
098 03	0
098 04	0
098 05	0
098 06	0
098 07	12
098 08	0
099 00	10
100 00	19
101 00	12
102 00 through 599 00	Open
600 00	26
601 00	0
602 00	27
603 00	29
604 00	29
605 00	29
606 00	29
607 00	0
608 00	28
609 00 and UP	Open

*Zero in this Column Indicates an Original WP/SWP

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

This is a list of TCTOs applicable to this manual. TCTOs will also be listed in the work packages to which they apply.

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229(V)-501	1 Jan 95	O/I	Incorporation of 30 Micron Oil Filter With Full-Flow Bypass Valve, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 90QA168C1)
2J-F100229-576	6 Dec 96	O/I	Installation of PN 4084415-01, Bracket Assembly, F100-PW-229 Engines, F-15/ F-16 Aircraft (ECP 96QA080)

SAFETY SUMMARY

INTRODUCTION

This technical order (T.O.) describes physical and chemical processes which may require the use of chemicals, solvents, paints, or other commercially available hazardous material. This T.O. also describes maintenance actions which may require handling or use of potentially dangerous parts or equipment.

Personnel performing maintenance procedures and practices included in this T.O. shall be familiar with safety precautions and procedures associated with chemicals and other hazardous materials, parts and equipment. The user of this T.O. shall consult their local safety and health staff and Material Safety Data Sheet (MSDS) concerning any questions on hazardous chemicals, personal protective equipment requirements, and appropriate handling and emergency procedures. The user shall become completely familiar with the manufacturer/supplier information and adhere to the procedures, recommendations, warnings, and cautions of the manufacturer/supplier for the safe use, handling, storage, and disposal of these materials. Disregarding safety precautions and procedures or performing unauthorized maintenance can cause engine or equipment damage, serious injury, illness, or death.

WARNING, CAUTION, and NOTE STATEMENTS

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, or statement which, if not strictly observed, could result in personal injury, loss of human life, or an acute/chronic health hazard.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, or statement which, if not strictly observed, could result in equipment damage or destruction.

WARNINGS (for personnel protection) or CAUTIONS (for equipment protection) precede selected procedures in this T.O. for additional emphasis. WARNINGS and CAUTIONS are used where emphasis beyond the general safety precautions and instructions are required because the equipment, procedures, or work environment represents an unusual situation (nonroutine use or application) to the technician. The WARNING or CAUTION applies each time the related step is repeated.

NOTES

A note describes an unusual procedure or condition which special attention must be paid for a particular reason.

Notes are not part of safety. A note does not replace a warning or caution.

SAFETY SUMMARY (continued)

BACKUP WRENCH

When torquing or breaking torque on any tube coupling nut, use a suitable wrench to apply torque to the fitting to which the part is attached. Failure to properly use a backup wrench can result in failure of tubes and accessories due to stress loading during torquing procedures.

BEARING HANDLING

The most common cause of bearing damage is attributed to improper preservation and mishandling. Do not handle bearings with bare hands. Wear approved gloves when handling bearings. Coat bearings with engine oil and store in labeled containers as matched sets. Ensure all bearing components have matching serial numbers before installation to prevent bearing failure due to mismatched contact surfaces.

BRAZING, SOLDERING, AND WELDING

Brazing, soldering and welding operations may produce fumes that can be harmful to breathe. Arc welding emits ultraviolet light, which can burn the skin and eyes. Provide adequate ventilation. Wear protective clothing/equipment. Ensure gas bottles are properly secured.

CABLES, ELECTRICAL

Small radius bends or severe flexing of electrical cables can result in damage to conductors and/or outer braid.

CARBON SEALS AND SEAL SEATS

Carbon seals and carbon seal seats are easily damaged and shall be handled with care. Do not allow carbon seals to come in contact with petroleum based solvents. These solvents will reduce the lubricity of the carbons and result in rapid seal wear. Do not handle carbon seals or seal seats with bare hands. Wear approved, lint free gloves.

CHEMICAL COMPOUNDS AND SOLUTIONS

Many of the chemical compounds and solutions used in cleaning, inspection, and repair are harmful to skin, eyes, and respiratory system. Many of the chemicals, including their vapors, may be poisonous, easily ignited, corrosive, and react violently with incompatible materials. Improper mixing and combining of these chemicals can produce violent reactions, rapid heat generation, and explosive/toxic gases. Heating certain chemicals will cause toxic gases to be produced. Observe manufacturer’s warning labels and Material Safety Data Sheet (MSDS) instructions for proper handling, storage, and disposal. Consult the local Safety Office for additional information.

COMPRESSED AIR

Compressed air can generate flying debris and can cause severe injury if air blast penetrates the skin or eyes. Reduce compressed air pressure for cleaning or drying to less than 30 psig. Use with effective chip guarding and personal protective equipment. Do not direct air blast toward other personnel.

SAFETY SUMMARY (continued)

COMPRESSED GASES

Many compressed gases are highly flammable/explosive and can cause suffocation at varied levels of concentration or exposure time. Some of the gases can freeze body tissue. Keep ignition sources away. Provide adequate ventilation. Wear protective clothing/equipment. Store in properly marked/labeled containers at approved locations. Do not use in confined areas which may create an explosive atmosphere. Refer to specific Material Safety Data Sheet (MSDS) for additional information.

DANGEROUS PRESSURE

Pressure system precautions apply to all equipment using gases and fluids at all ranges of pressure. To avoid injury, stand clear of tooling and parts being pressure tested when pressure is being applied. Proper tool installation, shielding and hose connections shall be ensured before applying pressure. Ensure all system components are compatible with pressures applied and pressure medium used. Pressure shall be applied slowly.

ELECTROSTATIC DISCHARGE (ESD)

Circuit card assemblies and their related components may be damaged by undetectable electrostatic discharge. Care shall be used during handling or repair of these items. Use electrostatic discharge precautionany standard operating procedures.

ENGINE AND ACCESSORIES - TEMPERATURE

Aircraft engines and accessories are extremely hot following operation. Allow sufficient time to cool or wear protective clothing/equipment when maintenance or inspection tasks are required following engine operation. Failure to comply may result in injury to personnel.

ENGINE AND CONTROLS PRESERVATION

Engines and engine controls shall be drained of all fuel and preserved before shipping. Failure to drain fuel can result in a fire hazard. Engine preservation replaces any fuel with oil, which acts as a corrosion preventing agent.

FOREIGN OBJECT DAMAGE (FOD)

Foreign objects can enter engine compartments and accessories during maintenance. Always be aware of the potential for foreign object damage (FOD) entering any uncovered opening of an engine or accessory. Always thoroughly clean parts and compartments to remove all foreign material. Make a final detail inspection of the work area when the job is finished. Follow standard operating procedures for tool and equipment accountability.

FOOD AND TOBACCO

Wash hands and face thoroughly prior to smoking tobacco products or eating food. Residue of the materials used in engine and equipment maintenance can cause serious health problems if ingested or inhaled in the smoke.

HEARING PROTECTION

The frequency and intensity of noise generated during some operations may cause an acute or chronic hearing impairment. Wear approved hearing protection equipment. Contact the local safety office or bioenvironmental engineering for further guidance.

SAFETY SUMMARY (continued)

HYDRAULIC TOOLING

Application of hydraulic pressure to tooling or engine parts can cause them to jump with enough force to cause personal injury. Excessive pressure applied to tooling by a hydraulic pump can cause a structural failure to the engine part and/or the tooling which could result in personal injury. Using a ram with a nonapproved part number or exceeding hydraulic pump pressure can result in excessive pressure being applied to tooling. Do not exceed ram capacity for a given tool. Stand clear of tooling and engine parts during hydraulic tool operations.

JEWELRY

Remove rings, watches, necklaces, and other metallic objects that may be snagged or cause shock or burn hazards.

LEAD SEALS

Lead seals shall only be removed when specifically called for in the procedure. Lead seals identify areas of critical adjustment that can only be attained at the Depot or Vendor level.

LIFTING, ROTATING, AND SUPPORTING

Personnel shall stay clear of objects being lifted during hoist operations or when objects are supported by temporary transition supports. To prevent personal injury, use adequate number of personnel and appropriately rated lifting/handling devices to lift or move objects. Unless specified in the procedures, personnel shall not work on objects suspended by a hoist or supported by temporary transition supports. Personnel shall be prepared for potential unbalanced conditions during hoist operations.

LIVE ELECTRICAL CIRCUITS

Do not work on electrical systems, replace components, or make adjustments to equipment with the electrical supply turned on. Under certain conditions, danger may exist even when the power control is in the "off" position due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit prior to servicing. Adhere to all lock-out/tag-out requirements.

MAINTENANCE STANDS AND FIXTURES

Ensure modules or assemblies are firmly secured to work stands or fixtures before performing maintenance procedures. Personal injury or damage to modules or assemblies may occur if a work stand or fixture slips.

METAL MACHINING PROCESSES

Metal machining processes may generate dust, fumes, filings, and/or shavings which may cause acute/chronic irritation to the skin, eyes, digestive tract, and respiratory system. Metallic dust vapors may form a fire hazard when exposed to heat, flame, or when in contact with oxidizing agents. Prior to performing any metal machining process, personnel shall consult their local safety and health staff and the Material Safety Data Sheet (MSDS) to become familiar with the hazards and protective measures for a specific metal.

SAFETY SUMMARY (continued)

MOVING ENGINE

Do not move an engine on work stand rails or transportation trailer without having installed proper supports, tierods, and flange adapters. Engine may shift or fall off rails and cause injury to personnel. When moving engine, do not push on engine. Use the engine support mount assemblies as a push point.

PACKING LUBRICATION (OIL AND FUEL SYSTEMS)

Use only the lubricant specified in the technical order to lubricate fuel and oil system packings. Use of an incompatible lubricant can cause oil foaming, clogging of critical fuel system filters, and packing deterioration leading to leakage, possible fire and engine shutdown.

PROTECTIVE CLOSURES AND COVERS

Install protective closures on all plumbing and components immediately upon removal. Install protective covers on engine modules, assemblies, parts, and compartments when not being worked.

QUICK-RELEASE PINS

Do not force quick release pins into place as this may damage the self-locking feature of the pins. The compatibility of quick release pins is determined by the part number. Intermixing of pin part numbers during installation can result in loss of or failure of the quick release pins.

SHARP EDGED BLADES

Many blades have sharp edges. Wear protective gloves when handling bladed rotors and when installing or removing blades from rotors. Blades should only be used in their designed holder or rotor.

SUPER-CHILLED/HEATED PARTS AND EQUIPMENT

Super-chilled or heated parts and the equipment or agents used to heat or chill can cause burns, frostbite, or both. Wear temperature resistant gloves and other related protective clothing/equipment when handling chilled or heated parts or equipment. Super-chilled parts are fragile due to a lower resistance to impact. Heating parts beyond specified temperature limits can degrade heat treat qualities and result in part failure.

TEMPERATURE NORMALIZING

Allow heated or chilled parts to reach room temperature before applying final torque to fasteners. Failure to comply may result in improperly seated parts and/or mistorqued fasteners.

WORK BOLTS AND WORK NUTS

Work bolts and work nuts shall be permanently marked to distinguish them from engine bolts and nuts. Do not apply lubricants to work bolts and work nuts that will be replaced by engine bolts and nuts which require a thread sealant. Sealants will not adhere to threads contaminated with lubricants.

WORK PACKAGE

WORK PACKAGE FORMAT TECHNICAL ORDERS

MASTER ALPHABETICAL INDEX OF F100-PW-229 ENGINE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 106

PAGE NO.	CHANGE NO.
1 - 2	29
2A	25
2B Blank	10
3 - 5	25
6	27
7	0
8	1
9	0
10	17
11	29
12 - 12A	25
12B Blank	1
13	14
14	8
15	7
16	1
17	0
18	25
19	24
20	29
21	25
22	14
23	0
24	15
25	27
26 - 27	19
28	0
29	8
30	0
31	27
32	0
33	27
34	28
35	0
36	12
37	1
38	11
39	14
40	10
41 - 42	0
43	28
44	12
45	8
46	25
47	14
48	5
49	15
50	19
51	27
52	14
53	7
54	26
55 - 56	0
57 - 58	25
59	7
60	27
61	0
62	14
63	1
64	24
65	1
66	20
67	0
68	25
69 - 71	27
72	14
73	0

LIST OF EFFECTIVE WP PAGES (Continued)

MASTER ALPHABETICAL INDEX

MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

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MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

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MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

MASTER ALPHABETICAL INDEX (continued)

W

WORK PACKAGE

INTRODUCTION TO MANUAL SET

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 42

REFERENCE MATERIAL REQUIRED

Title	Number
U.S. Air Force Materials Deficiency Reporting and Investigating System -	T.O. 00-35D-54
Illustrated Parts Breakdown -	T.O. 2J-F100-54
Support Equipment and Numerical Tool List - - - - - - - - - - -	T.O.2J-F100-53-3
Locally Manufactured Support Equipment - - - - - - - - - - - -	WP 050 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

(See Table 1.)

a. This work package contains general information on the depot maintenance manual set for the F100-PW-229 engine.

b. The F100-PW-229 engine is manufactured by United Technologies Corporation, Pratt & Whitney, Large Military Engines, P.O. Box 109600, West Palm Beach, Florida 33410-9600 USA.

c. This work package describes:

- Purpose and scope of the depot maintenance manual set
- Instructions on how to use the manual set
- Additional relevant information concerning the manual set

d. The manuals comprising the depot maintenance manual set and their designations are listed in table 1.

2. PURPOSE AND SCOPE.

a. The purpose of the depot maintenance manual set is to provide specific instructions required by Air Force personnel to perform depot maintenance on the F100-PW-229 engine.

b. Individual maintenance manuals within the manual set contain instructions for:

- Disassembly
- Cleaning
- Inspection
- Repair
- Replacement
- Assembly
- Test

d. Other manuals within the manual set provide information on:

- Engine description
- Support equipment

2A. CHANGE REQUEST.

a. Recommendations for specific changes to this technical order shall be submitted on an AFTO Form 22 to SA-ALC/LPCQ (TOMA), Kelly AFB, TX 78241-6421 in accordance with T.O. 00-5-1.

Table 1. Depot Maintenance Manual Set

T.O. Title	T.O. Designation
Introduction and General Information	T.O. 2J-F100-53-1
On Condition Maintenance	T.O. 2J-F100-53-2
Support Equipment and Numerical Tool List	T.O. 2J-F100-53-3
Engine Accessories and Rigging Procedures	T.O. 2J-F100-53-4
Engine	T.O. 2J-F100-53-5
Inlet/Fan Module	T.O. 2J-F100-53-6
Core Engine Module	T.O. 2J-F100-53-7
Rear Compressor Drive Turbine	T.O. 2J-F100-53-8
Fan Drive Turbine Module	T.O. 2J-F100-53-9
Augmentor Duct and Nozzle Module	T.O. 2J-F100-53-10
Gearbox Module	T.O. 2J-F100-53-11
Engine Test	T.O. 2J-F100-11-2

3. GENERAL STRUCTURE OF THE DEPOT MAINTENANCE MANUAL SET (WORK PACKAGE CONCEPT).

a. Each manual is divided into work packages (WP).

b. A work package (WP) is a self-contained set of procedures arranged on the basis of work requirements supporting significant tasks and parts.

c. Division of information into specific work packages depends on:

- Type of information
- Complexity of the maintenance procedure

d. Work packages can be subdivided into subordinate work packages (SWP) when a division into a WP is not enough to present:

- Logical sequence of information or procedures
- Differences in configurations
- Additional material

e. Subordinate work packages containing new information are added as the manuals mature.

4. GENERAL WORK PACKAGE INFORMATION.

(See Figure 1.)

a. Each WP/SWP contains the following introductory material:

- Manual designation and WP/SWP number
- WP/SWP title
- List of effective WP/SWP pages
- Reference material
- Applicable time compliance technical orders (TCTO)
- Consumable materials
- Expendable items
- Applicable support equipment
- Illustrated support equipment

b. Figure 1 illustrates typical WP/SWP introductory material.

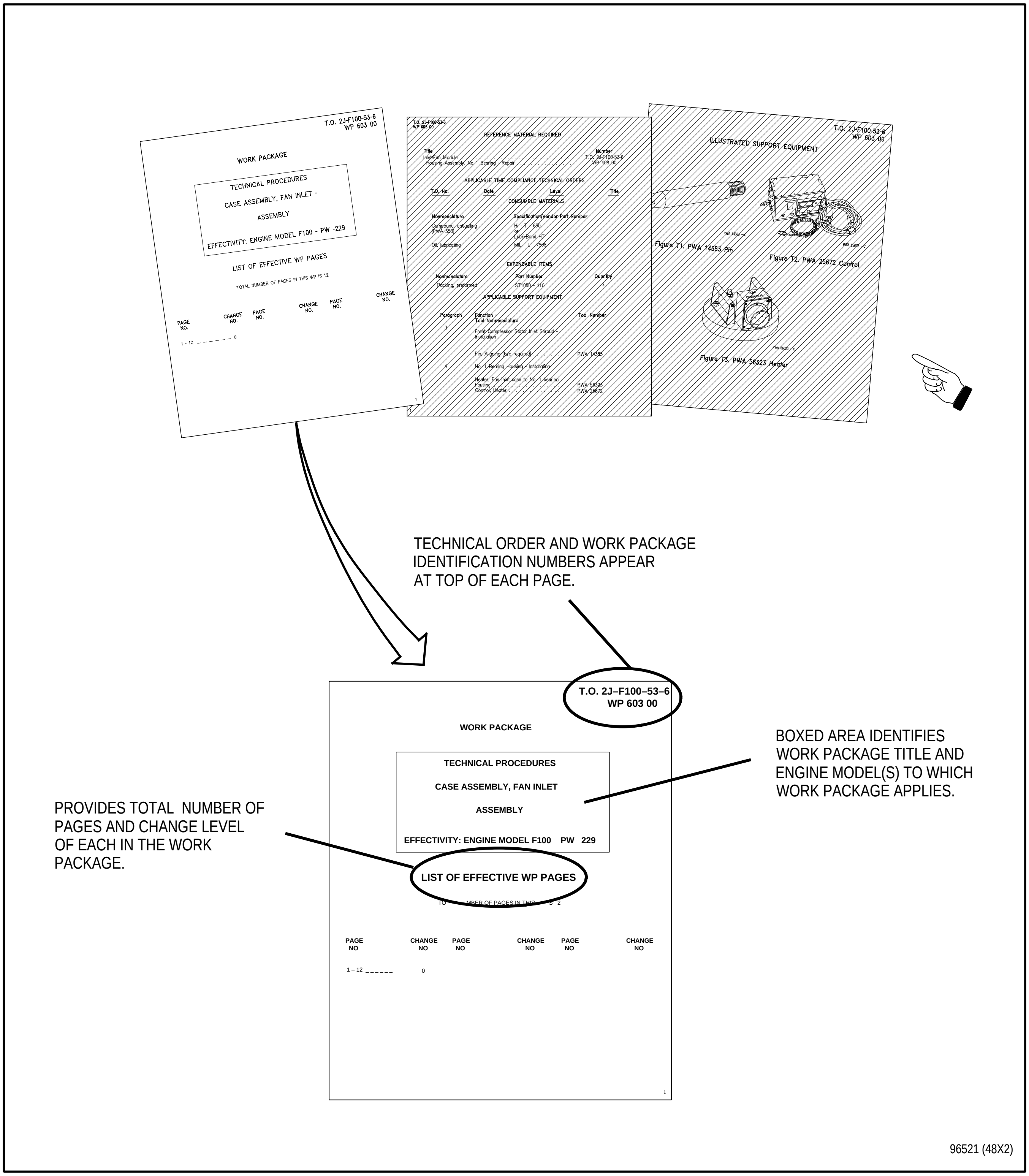


Figure 1. Work Package/Subordinate Work Package Introductory Material (Sheet 1 of 4)

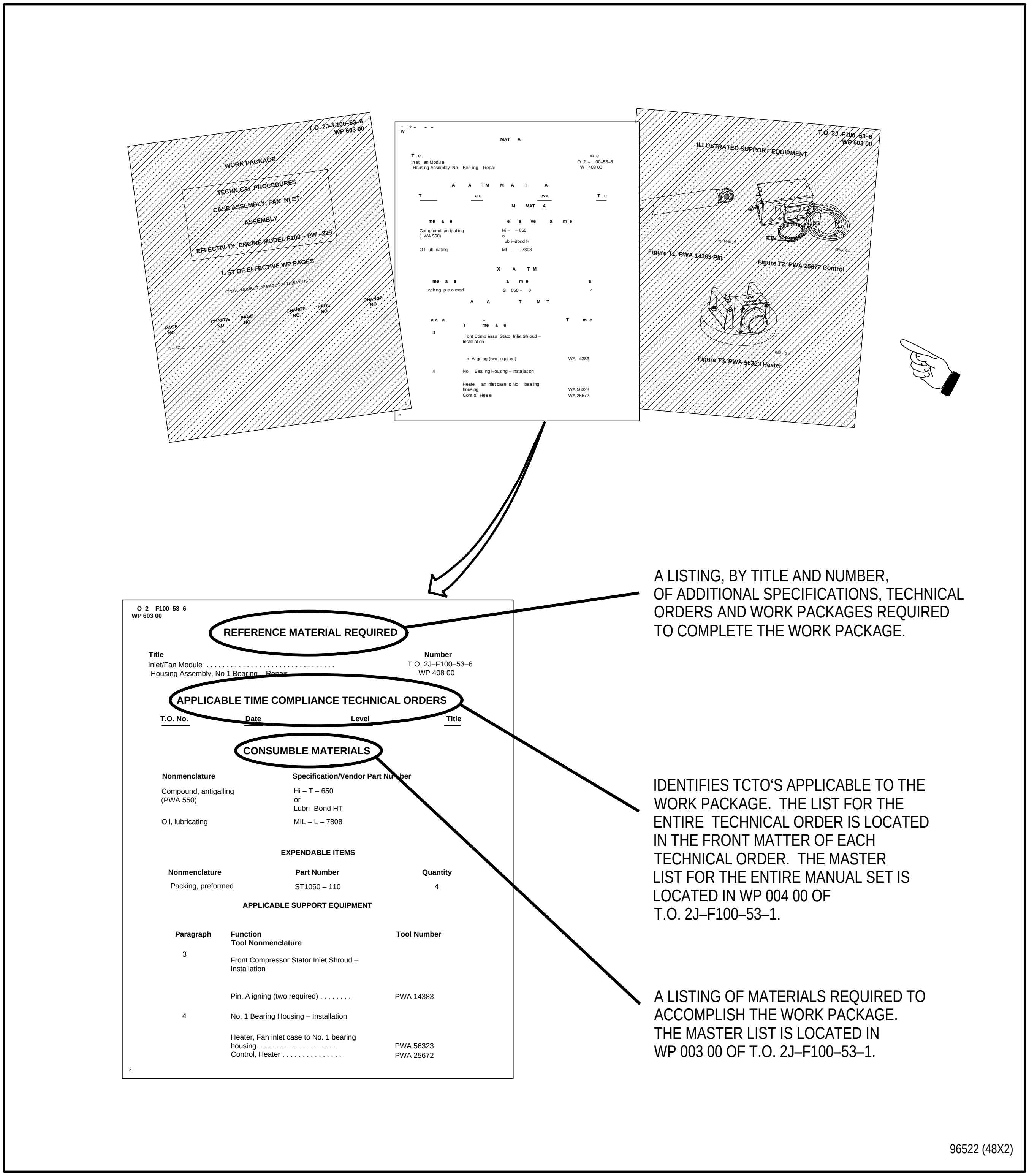


Figure 1. Work Package/Subordinate Work Package Introductory Material (Sheet 2 of 4)

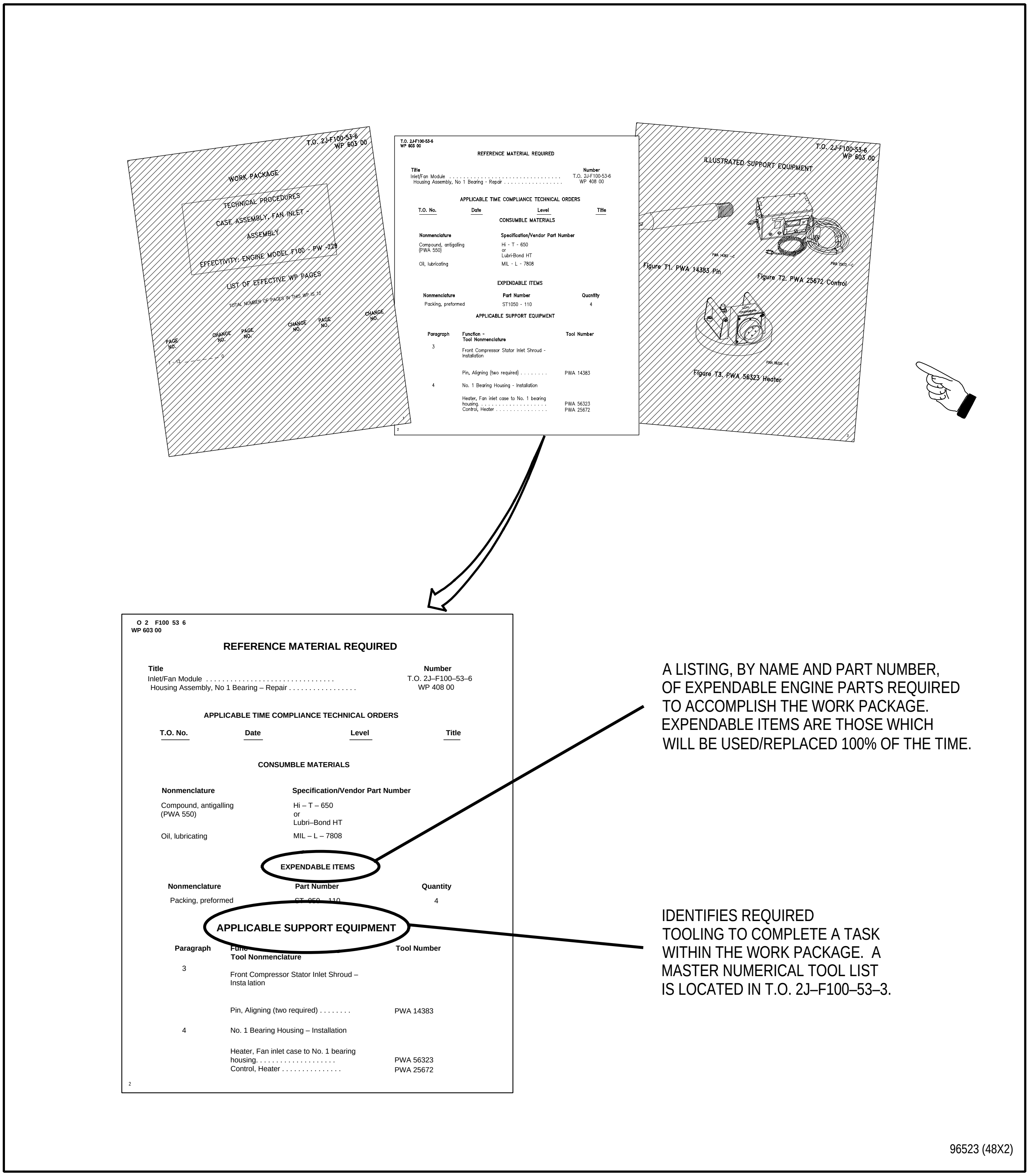


Figure 1. Work Package/Subordinate Work Package Introductory Material (Sheet 3 of 4)

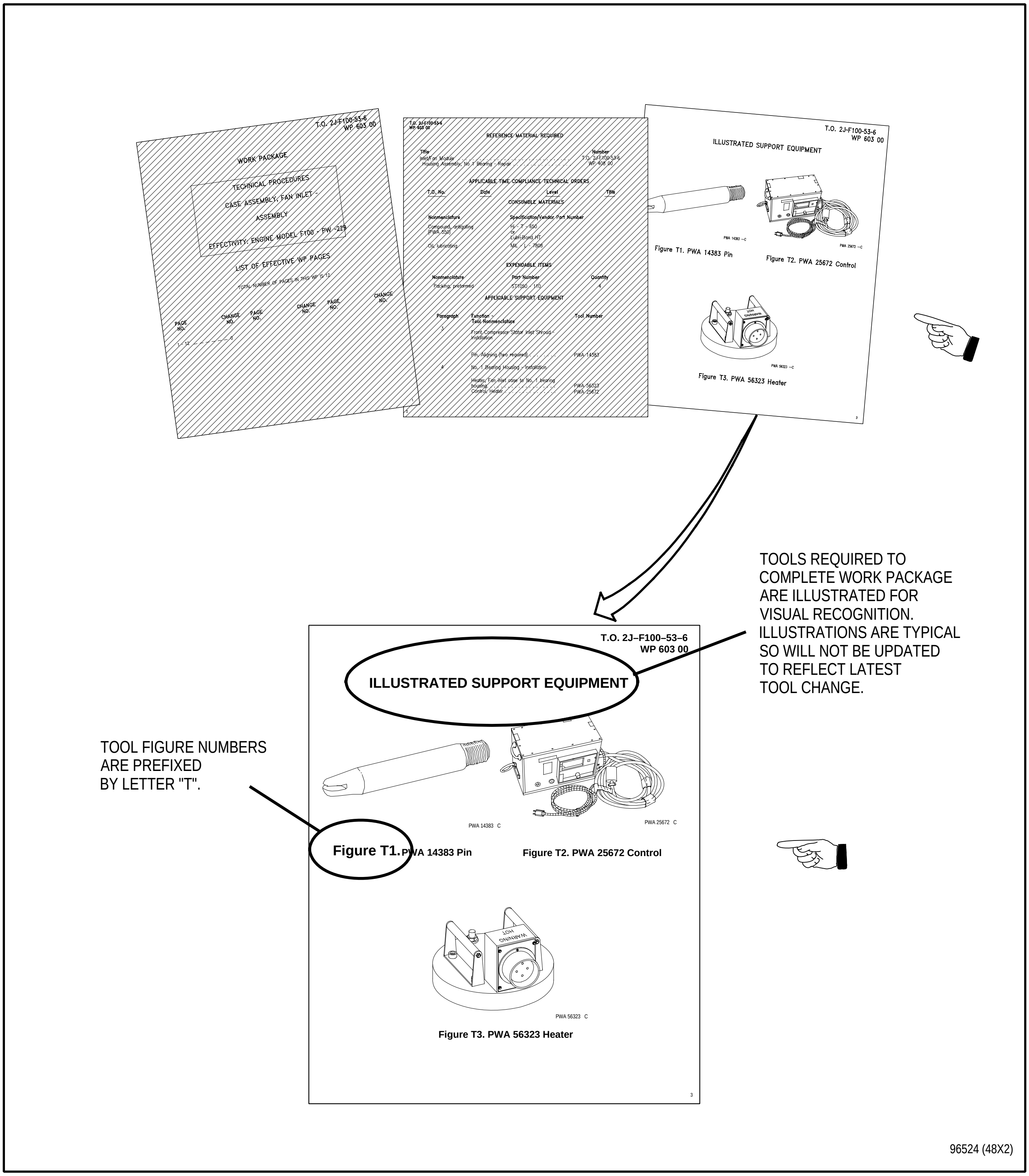


Figure 1. Work Package/Subordinate Work Package Introductory Material (Sheet 4 of 4)

5. GENERAL DESCRIPTION OF THE DEPOT MAINTENANCE MANUAL SET.
(See FO-1.)

a. The depot maintenance manual set contains 15 separate technical orders (T.O.).

b. The technical orders within the manual set fall in the following categories:

- Supporting T.O.s
- Engine T.O.
- Module T.O.s
- Test T.O.

c. FO-1 graphically shows the organization of the depot maintenance manual set.

d. Each category of technical orders is described in the following paragraphs.

6. SUPPORTING TECHNICAL ORDERS.
(See Tables 2 and 3.)

a. T.O. 2J-F100-53-1, Introduction and General Information, contains:

- Master alphabetical index for the manual set
- Introductory information, including instructions on how to use the manual set
- Master list of consumable materials
- Master list of applicable TCTOs
- Engine general and systems description

b. T.O. 2J-F100-53-1 also includes general maintenance procedures which are referenced throughout the manual set. These general procedures include:

- Disassembly, assembly, bearing handling, and marking of parts
- Cleaning procedures by SPOP number
- Inspection procedures (fluorescent penetrant and magnetic particle)
- Repair procedures

c. T.O. 2J-F100-53-1 is organized as shown in table 2.

Table 2. Work Package Numbering System for T.O. 2J-F100-53-1, Introduction and General Information

Work Package Numbering Series*	Subject
-	Front Matter
001 00	Master Alphabetical Index
002 00	Introduction
003 00	Master List of Consumable Materials
004 00	Master List of Applicable TCTOs
005 00 thru 019 00	General Engine and Systems Description
020 00 thru 029 00	General Procedures (Disassembly, Assembly, Bearing Handling, Marking of Parts)
030 00 thru 069 00	General Cleaning Procedures
070 00 thru 089 00	General Inspection Procedures
090 00 thru 599 00	General Repair Procedures
600 00 thru 607 00	Qualified Repair Source List

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary later.

d. T.O. 2J-F100-53-2, On-Condition Maintenance contains instructions for the scheduled and unscheduled maintenance required to restore equipment to a serviceable condition.

e. The scheduled maintenance provides inspections for parts completing specified cycle intervals. The unscheduled maintenance provides instructions to gain quick access to areas requiring maintenance so that total disassembly/assembly procedures contained in other manuals do not have to be used. See table 3 for the work package numbering system for T.O. 2J-F100-53-2.

f. T.O. 2J-F100-53-3, Support Equipment and Numerical Tool List, identifies all the support equipment used in the manual set.

g. The numerical tool list references each tool, its blueprint nomenclature, and the technical order(s) and the work package(s) in which it is used.

h. T.O. 2J-F100-53-3 also provides tool maintenance for selected tools, a list of tools covered by separate publications and all data required to make locally manufactured tools.

Table 3. Work Package Numbering System For T.O. 2J-F100-53-2, On Condition Maintenance

Work Package Numbering Series*	Subject
-	Front Matter
001 00	Alphabetical Index
002 00	Introduction
003 00 thru 019 00	Scheduled Maintenance
020 00 thru 099 00	Unscheduled Maintenance

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary later.

7. TEST TECHNICAL ORDER.
(See Table 4.)

a. T.O. 2J-F100-11-2, Engine Test, provides information on pretest, test, post test, and troubleshooting information for the F100-PW-229 engine.

b. T.O. 2J-F100-11-2 troubleshooting data includes:

- Indication of trouble
- Determination of cause
- Necessary remedies

c. T.O. 2J-F100-11-2 is organized as shown in table 4.

Table 4. Work Package Numbering System for T.O. 2J-F100-11-2, Engine Test

Work Package Numbering Series*	Subject
-	Front Matter
001 00	Alphabetical Index
002 00	Introduction
003 00 thru 099 00	Engine Dress
100 00 thru 199 00	Engine Pretest
200 00 thru 299 00	Engine Test
300 00 thru 399 00	Engine Posttest
400 00 and 499 00	Engine Undress
500 00 and up	Troubleshooting

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary later.

8. ENGINE TECHNICAL ORDER.
(See Table 5.)

a. T.O. 2J-F100-53-5, Engine, subjects and respective work package numbering series are listed in table 5.

b. Pictorial indexes are provided in the technical order to help maintenance personnel match parts and procedures to the work packages which address them.

Table 5. Work Package Numbering System for T.O. 2J-F100-53-5, Engine

Work Package Numbering Series*	Subject
-	Front Matter
001 00	Alphabetical Index
002 00	Introduction
003 00 thru 019 00	Engine Removal/ Installation in Shipping Trailer
020 00 thru 039 00	Borescoping
040 00 thru 059 00	Engine Handling
060 00 thru 099 00	Engine External Tubing
100 00 thru 199 00	Module and Fan Ducts Removal
200 00 thru 299 00	Engine Nonmodular Parts Disassembly
300 00 thru 399 00	Engine Nonmodular Parts Cleaning
400 00 thru 499 00	Engine Nonmodular Parts Inspection
500 00 thru 599 00	Engine Nonmodular Parts Repair
600 00 thru 699 00	Engine Nonmodular Parts Assembly
700 00 thru 799 00	Module and Fan Ducts Installation
800 00 and up	Table of Limits and Clearance Charts

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary later.

9. MODULE AND ACCESSORY TECHNICAL ORDERS.
(See Tables 6 and 7.)

a. Technical orders included in this category are as follows:

- T.O. 2J-F100-53-4, Engine Accessories and Rigging Procedures
- T.O. 2J-F100-53-6, Inlet/Fan Module
- T.O. 2J-F100-53-7, Core Engine Module
- T.O. 2J-F100-53-8, Rear Compressor Drive Turbine
- T.O. 2J-F100-53-9, Fan Drive Turbine Module
- T.O. 2J-F100-53-10, Augmentor Duct and Nozzle Module
- T.O. 2J-F100-53-11, Gearbox Module

b. Each module technical order contains a pictorial index which matches parts to the work packages that address them.

c. The work packages in T.O. 2J-F100-53-6 through T.O. 2J-F100-53-11 are arranged in blocks of numbers according to procedure. The number of a work package therefore reveals the type of procedure it contains. These technical orders are organized as shown in table 6.

Table 6. Work Package Numbering System for T.O. 2J-F100-53-6 Through T.O. 2J-F100-53-11

Work Package Numbering Series*	Subject
-	Front Matter
001 00	Alphabetical Index
002 00	Introduction
003 00 thru 009 00	Module Removal/ Installation in Shipping Container
010 00 thru 019 00	Module Dismantling into Subassemblies
020 00 thru 199 00	Disassembly of Subassemblies
200 00 thru 299 00	Cleaning
300 00 thru 399 00	Inspection
400 00 thru 599 00	Repair
600 00 thru 699 00	Assembly of Subassemblies
700 00 thru 799 00	Module Final Assembly
800 00 and up	Table of Limits and Clearance Charts

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary.

d. The work packages in T.O. 2J-F100-53-4 (engine accessories and rigging procedures) are organized as follows:

(1) Each work package contains all the procedures necessary to perform depot maintenance on the particular component covered. These procedures include:

- Removal
- Disassembly
- Cleaning
- Inspection and repair
- Assembly
- Installation

(2) T.O. 2J-F100-53-4 is organized as shown in table 7.

e. The accessory work packages (T.O. 2J-F100-53-4) are divided into two main groups:

- Accessory work packages
- Rigging work packages

(1) The accessory work packages are further arranged by system.

(2) For example, all fuel system accessories, are grouped together, the oil system work packages are grouped together, and so on.

Table 7. Work Package Numbering System For T.O. 2J-F100-53-4 Engine Accessories and Rigging Procedures

WP Block Numbers*	Subject
-	Front Matter
001 00	Alphabetical Index
002 00	Introduction
003 00	Accessories Covered By Separate Publication
004 00 through 099 00	Engine Accessories
100 00 through 199 00	Rigging Procedures
200 00	Table of Limits and Clearance Charts

* Not every work package number in each block of numbers has been used. Many have been left open so that additional work packages can be added as necessary.

10. INDEXING OF THE DEPOT MAINTENANCE MANUAL SET.

a. Work package (WP) 001 00 in T.O. 2J-F100-53-1 contains a master index of all information contained in the depot maintenance manual set. This index lists subjects alphabetically, and references the technical order(s) and work package(s) where each subject is addressed.

b. The WP 001 00 in each of the other technical orders contains a similar index of all information contained in that technical order only.

11. WORK PACKAGE FEATURES.

a. Work packages within the depot maintenance manual set contain the following features, as necessary, to aid the user in performing depot maintenance tasks:

- Pictorial index
- Inspection/repair figures
- Table of limits and clearance charts

b. Each of these features are described in the following paragraphs.

12. PICTORIAL INDEX.
(See Figures 2 and 3.)

a. The engine and module technical orders each contain a pictorial index as a visual aid in matching parts and procedures to the work package(s) which address them.

b. Two types of pictorial index are used depending on the format of technical order in which they appear.

(1) Figure 2 illustrates a typical pictorial index used in T.O. 2J-F100-53-6 through T.O. 2J-F100-53-11.

(2) Figure 3 illustrates a typical pictorial index used in T.O. 2J-F100-53-4.

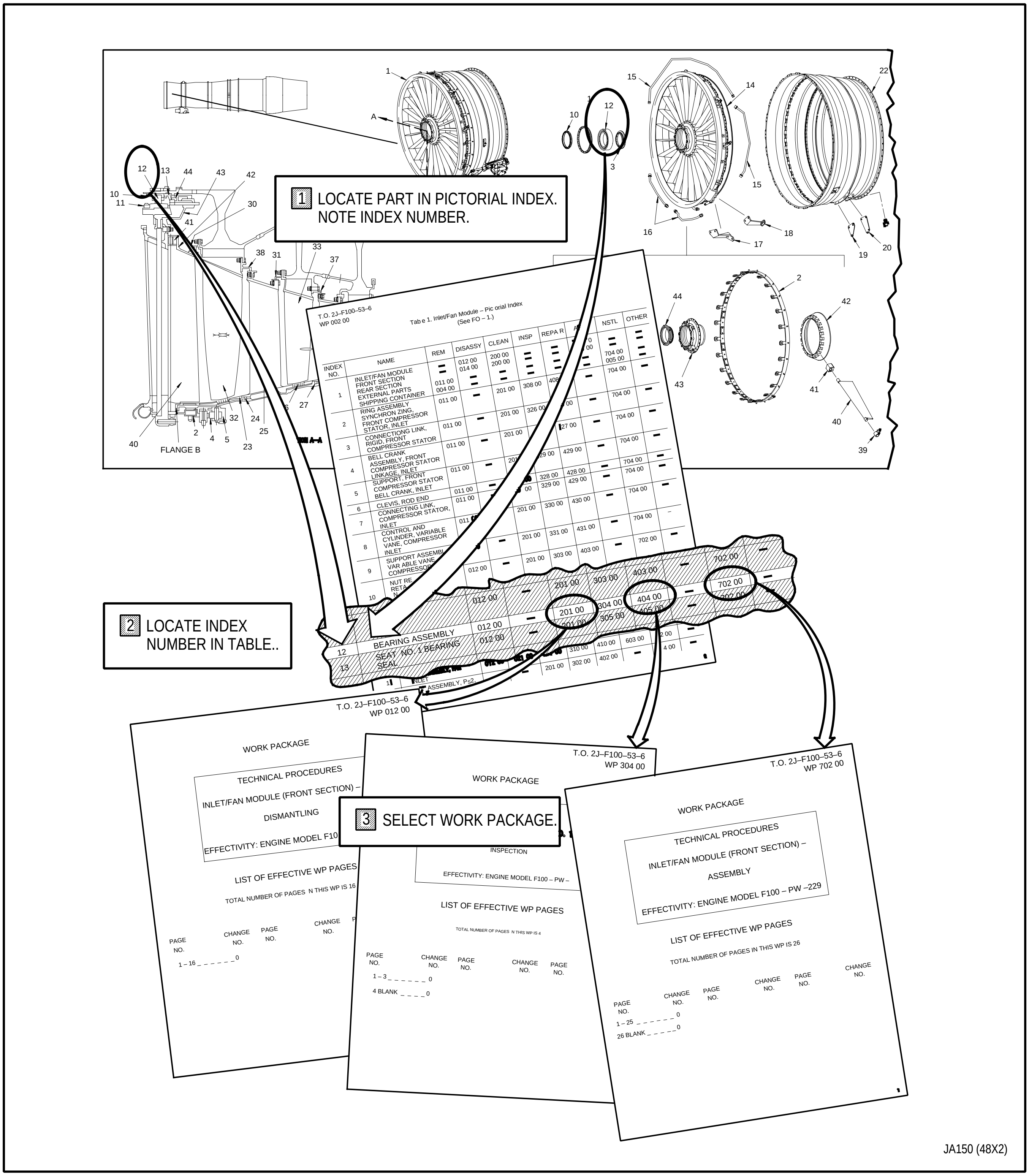


Figure 2. Pictorial Index - T.O. 2J-F100-53-6 Through T.O. 2J-F100-53-11

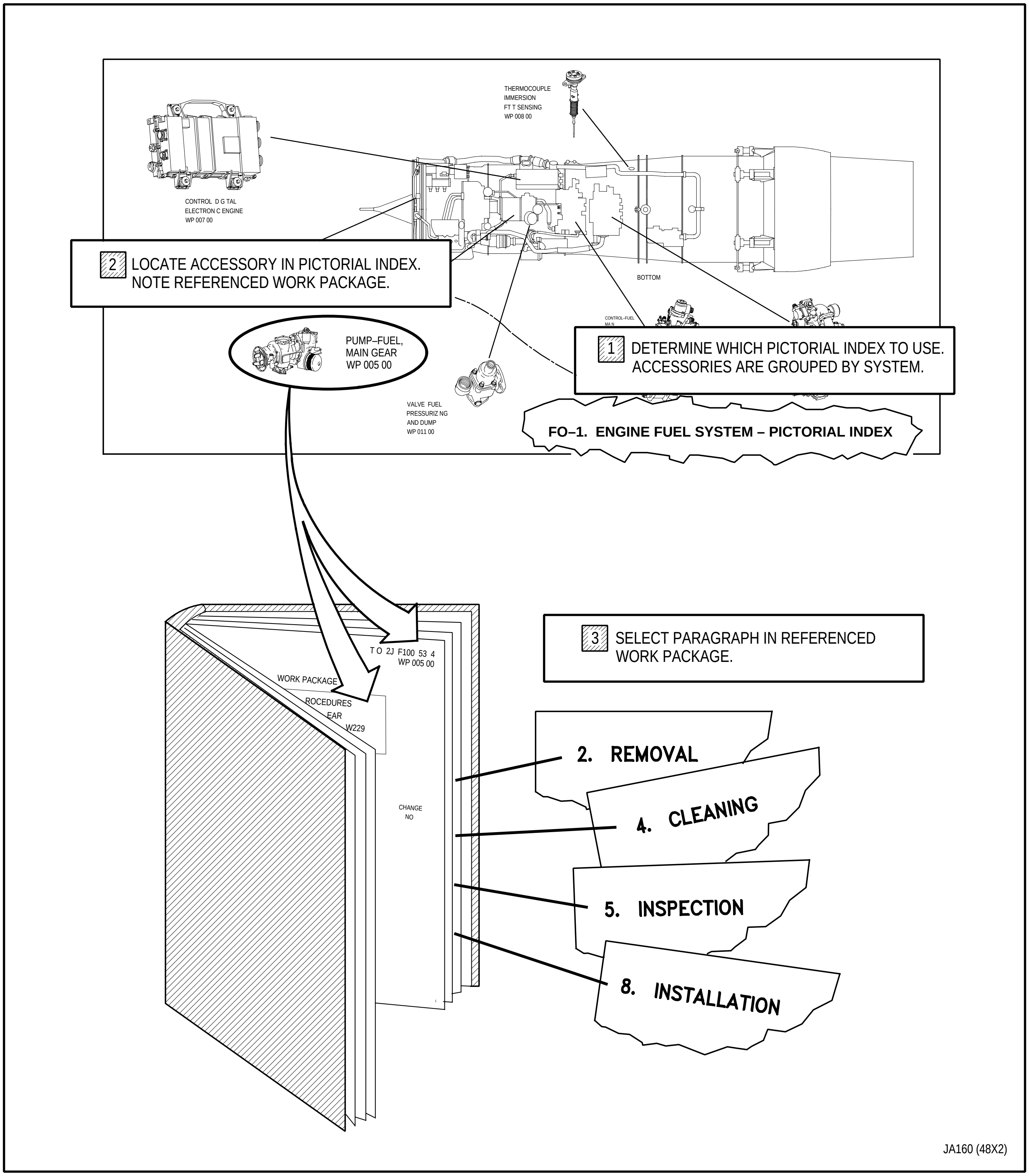


Figure 3. Pictorial Index - T.O. 2J-F100-53-4

13. INSPECTION/REPAIR FIGURES.

(See Figure 4.)

a. For each part being visually inspected, a figure is provided which identifies each area to be inspected and the defects to look for.

b. Inspection areas are identified by number in the figure. This number corresponds to the same number in the figure legend. (See figure 4, Sheet 1.)

c. The inspection figure legend defines the maximum serviceable limit and the maximum reparable limit for a particular defect in the part being inspected.

d. If a repair procedure for the defect exists, the corrective action column either:

- identifies the repair procedure,
- defines the procedure, or
- references the T.O. and work package which contains the repair procedure.

e. If the defect cannot be repaired, the corrective action column requires the part or assembly to be replaced.

f. Figure 4, Sheet 2 defines the inspection criteria used in the figure legends.

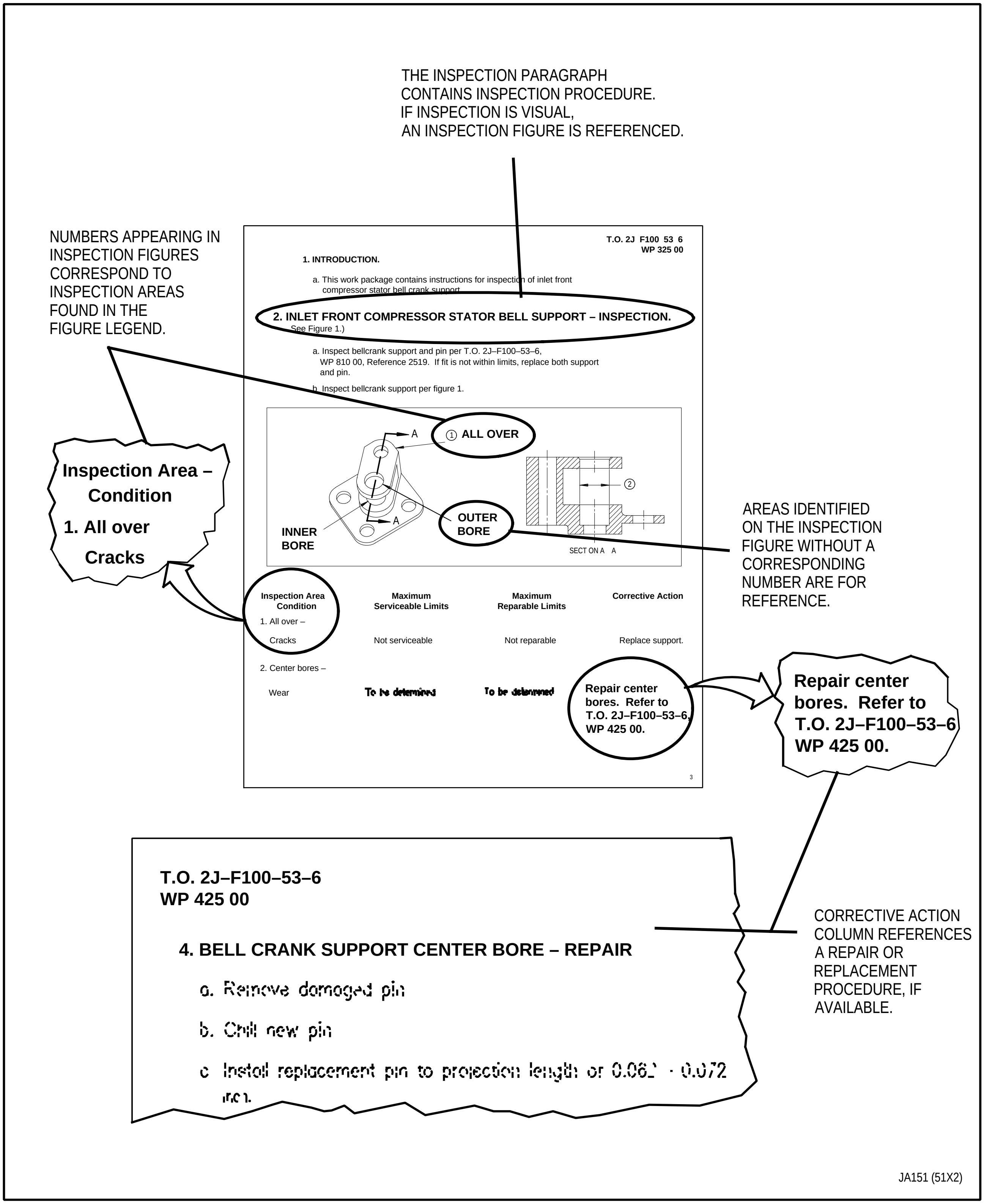


Figure 4. Inspection/Repair Figures and Figure Legends - (Sheet 1 of 2)

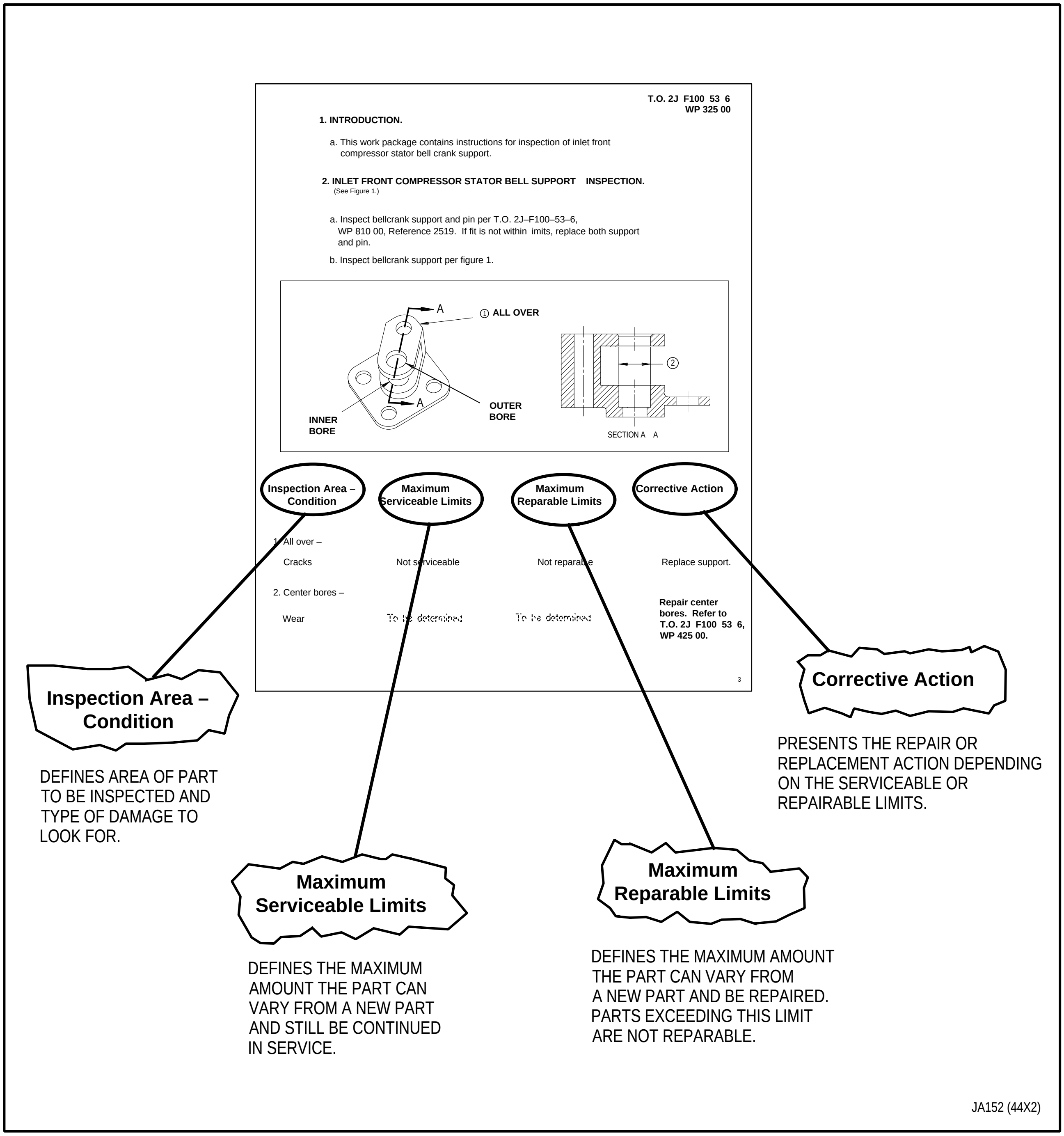


Figure 4. Inspection/Repair Figures and Figure Legends - (Sheet 2 of 2)

14. PRELIMINARY INSTRUCTIONS/ FOLLOW-ON MAINTENANCE.
(See Figure 5.)

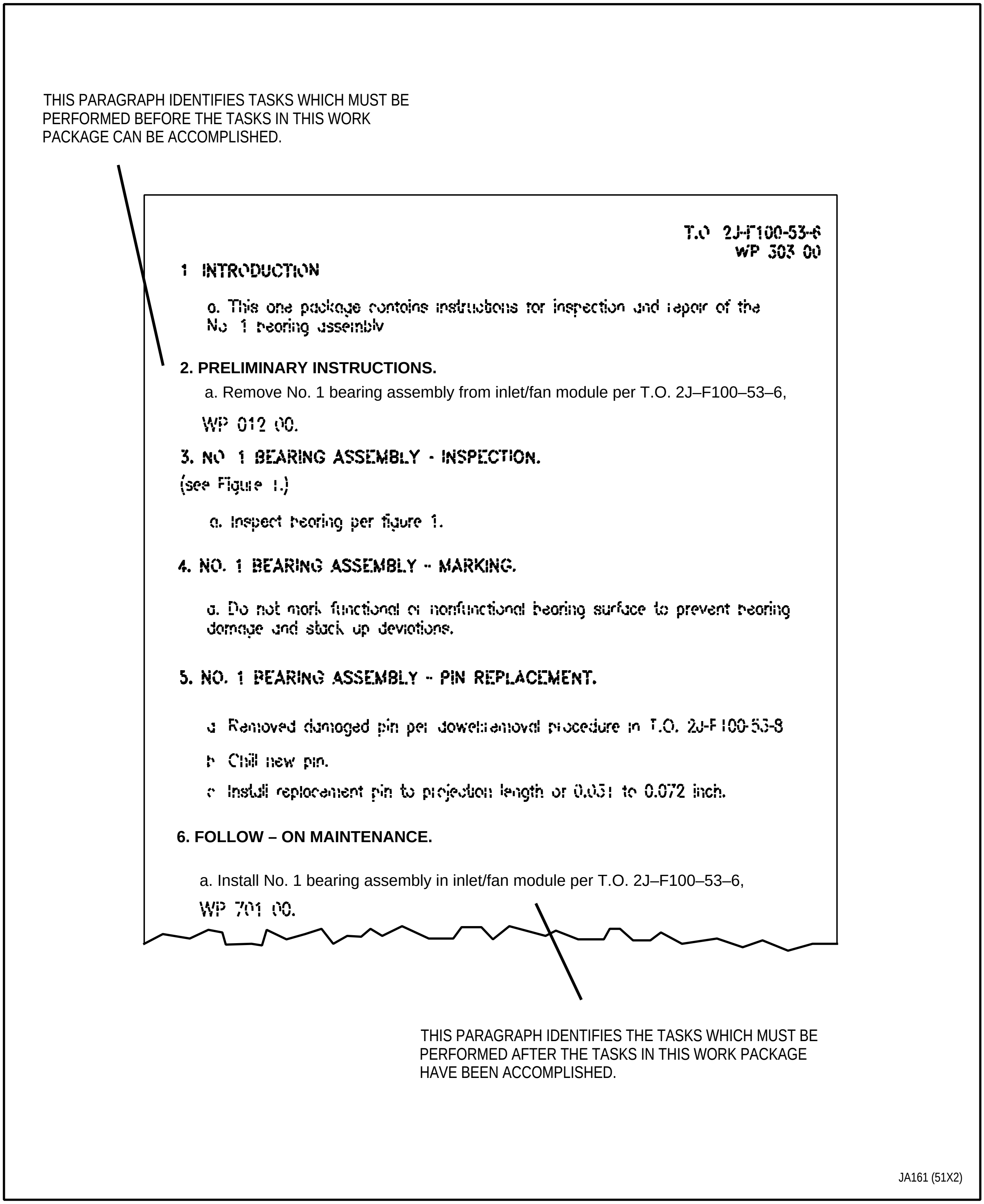
a. When applicable, work packages contain:

- preliminary instructions
- follow-on maintenance

b. Preliminary instructions provide information on tasks which must be performed before the tasks in the work package can be accomplished.

c. Follow-on maintenance instructions provide information on tasks which must be performed after the tasks in the work package have been accomplished.

d. An example of the use of preliminary and follow-on maintenance instructions is shown in figure 5.


THIS PARAGRAPH IDENTIFIES TASKS WHICH MUST BE PERFORMED BEFORE THE TASKS IN THIS WORK PACKAGE CAN BE ACCOMPLISHED.

T.O. 2J-F100-53-6
WP 303 00

1 INTRODUCTION

a. This one package contains instructions for inspection and repair of the No. 1 bearing assembly

2. PRELIMINARY INSTRUCTIONS.

a. Remove No. 1 bearing assembly from inlet/fan module per T.O. 2J–F100–53–6, WP 012 00.

3. NO. 1 BEARING ASSEMBLY - INSPECTION.
(see Figure 1.)

a. Inspect bearing per figure 1.

4. NO. 1 BEARING ASSEMBLY - MARKING.

a. Do not mark functional or nonfunctional bearing surface to prevent bearing damage and stack up deviations.

5. NO. 1 BEARING ASSEMBLY - PIN REPLACEMENT.

a. Removed damaged pin per dowel removal procedure in T.O. 2J-F100-53-8

b. Chill new pin.

c. Install replacement pin to projection length of 0.031 to 0.072 inch.

6. FOLLOW – ON MAINTENANCE.

a. Install No. 1 bearing assembly in inlet/fan module per T.O. 2J–F100–53–6, WP 701 00.

THIS PARAGRAPH IDENTIFIES THE TASKS WHICH MUST BE PERFORMED AFTER THE TASKS IN THIS WORK PACKAGE HAVE BEEN ACCOMPLISHED.

JA161 (51X2)

Figure 5. Preliminary Instructions/Follow-On Maintenance

15. TABLE OF LIMITS AND CLEARANCE INDEX CHARTS.

(See Figures 6, 7, and 8.)

a. Fits and clearances.

(1) Part tolerances, fits, and limits for jet engines are among the most precise required throughout the manufacturing industry.

(2) Such precision is necessary because of critical specifications controlling:

- Compression
- Pressure sealing
- High speed torque
- Rotating part balance
- Extreme combustion temperatures

(3) The size relationship of one part to its mating part is known as a fit. There are three types of fits as shown in figures 6 and 7:

- Clearance fit
- Interference fit
- Transition fit

(4) Because parts cannot be manufactured on a large scale to the exact same dimension, tolerances, or slight deviations are allowed and taken into consideration when fits are determined.

b. The Table of Limits and Clearance Index Charts provide assembly controls for specified engine parts. They provide:

- Spring pressures
- Special torques
- Fits
- Clearances

c. The Table of Limits identifies parts tolerances, fits, and limits. Each Table of Limits entry is assigned a reference number, which also appears on a Clearance Index Chart illustration. The chart is used for part identification and to indicate where in the engine the referenced limit or value applies.

d. The Table of Limits and Clearance Index Charts are contained in the last work package of each applicable technical order. Figure 8 illustrates how to use the Table of Limits and Clearance Index Charts.

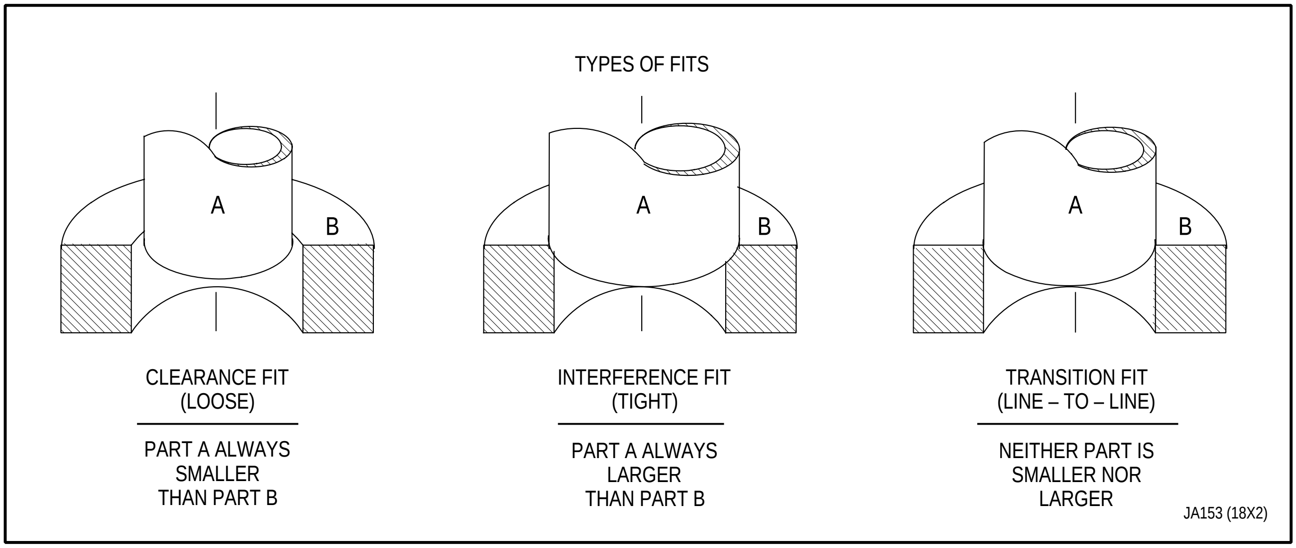


Figure 6. Types of Fits

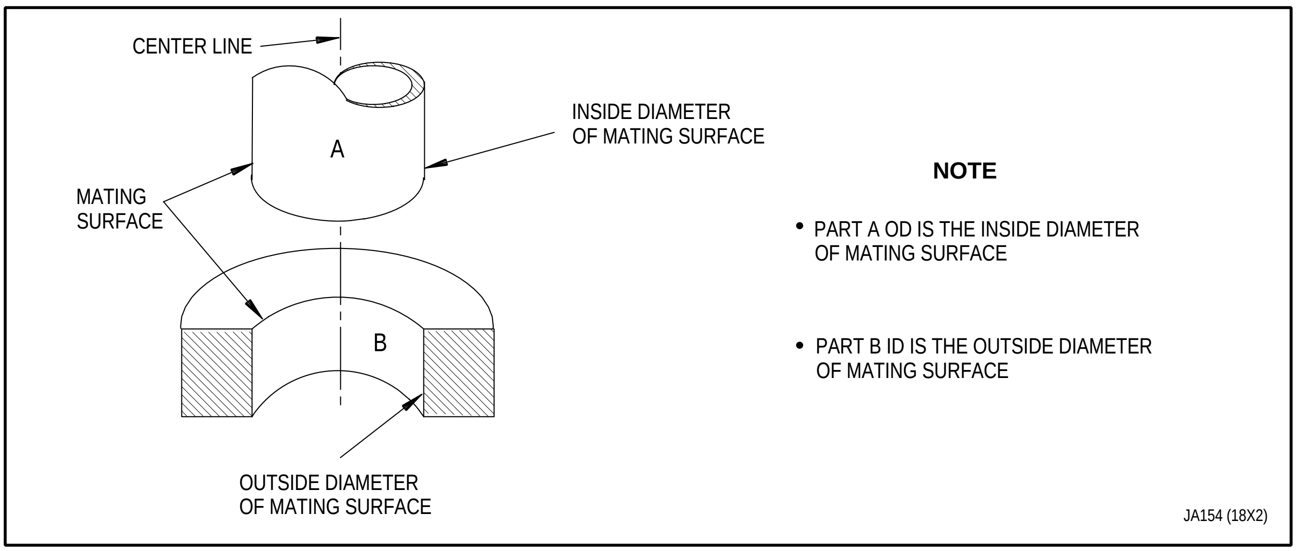


Figure 7. Determining Inside Diameter/Outside Diameter of Mating Surface

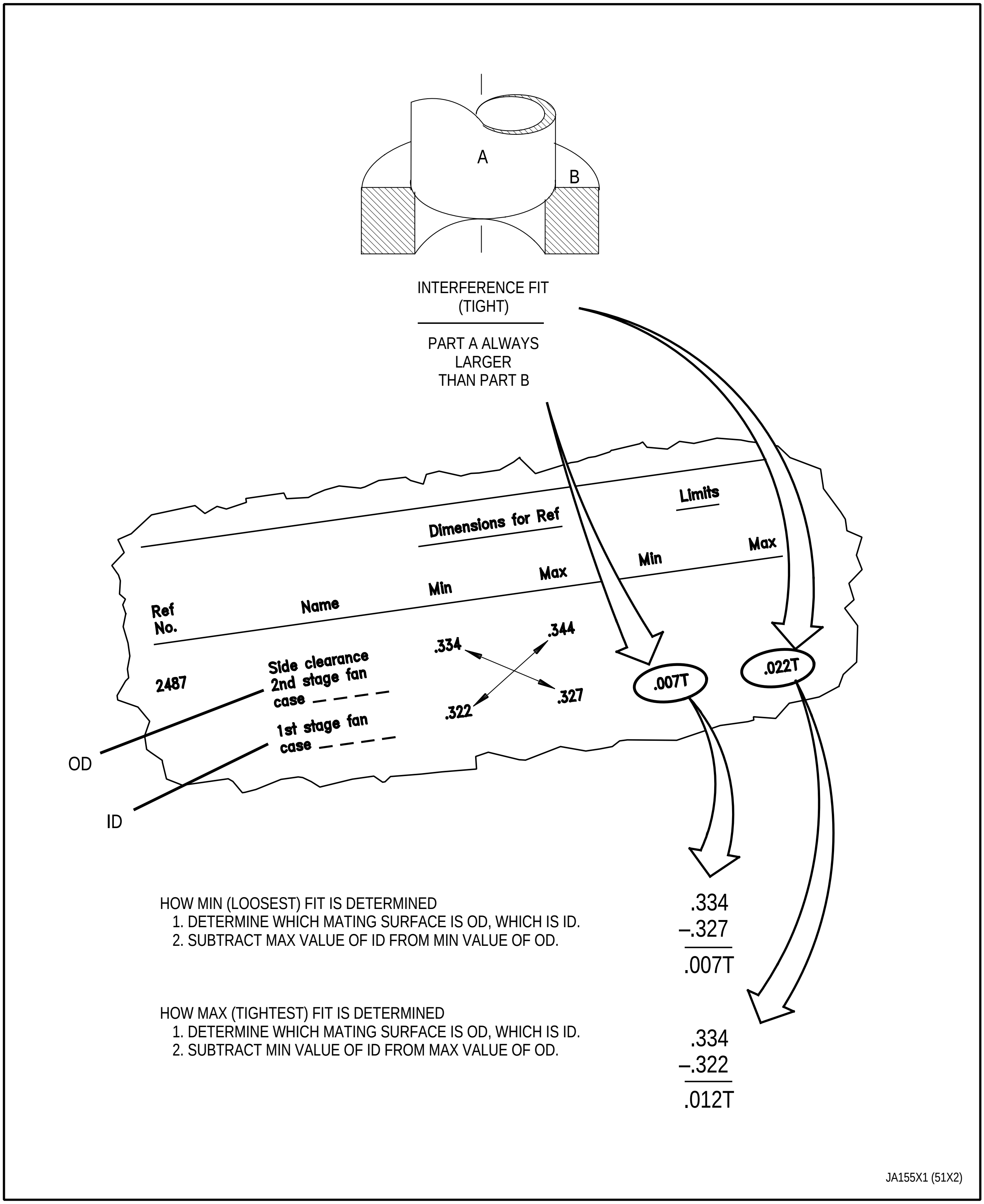


Figure 8. Table of Limits - How-To-Use (Sheet 1 of 5)

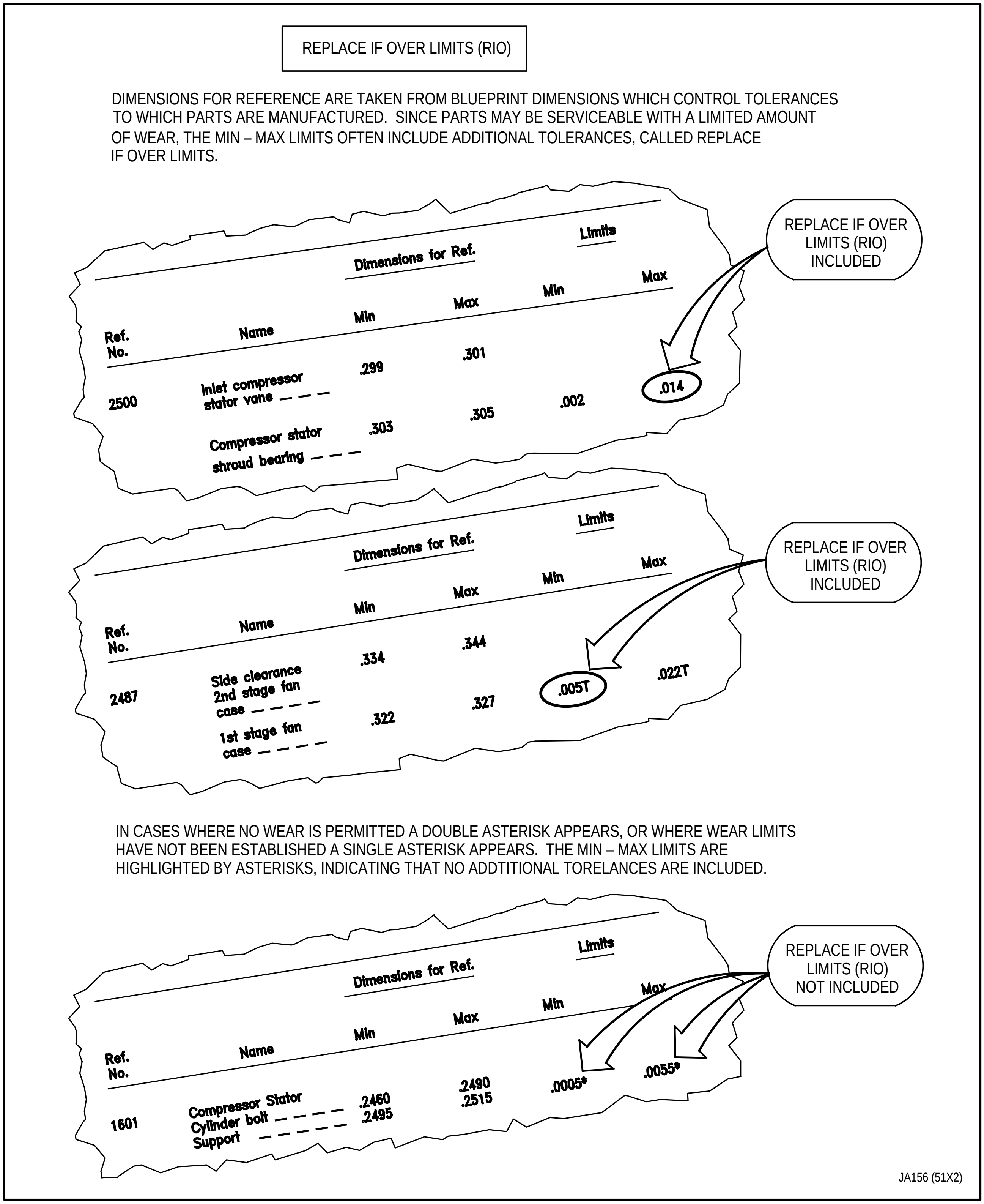


Figure 8. Table of Limits - How-To-Use (Sheet 2 of 5)

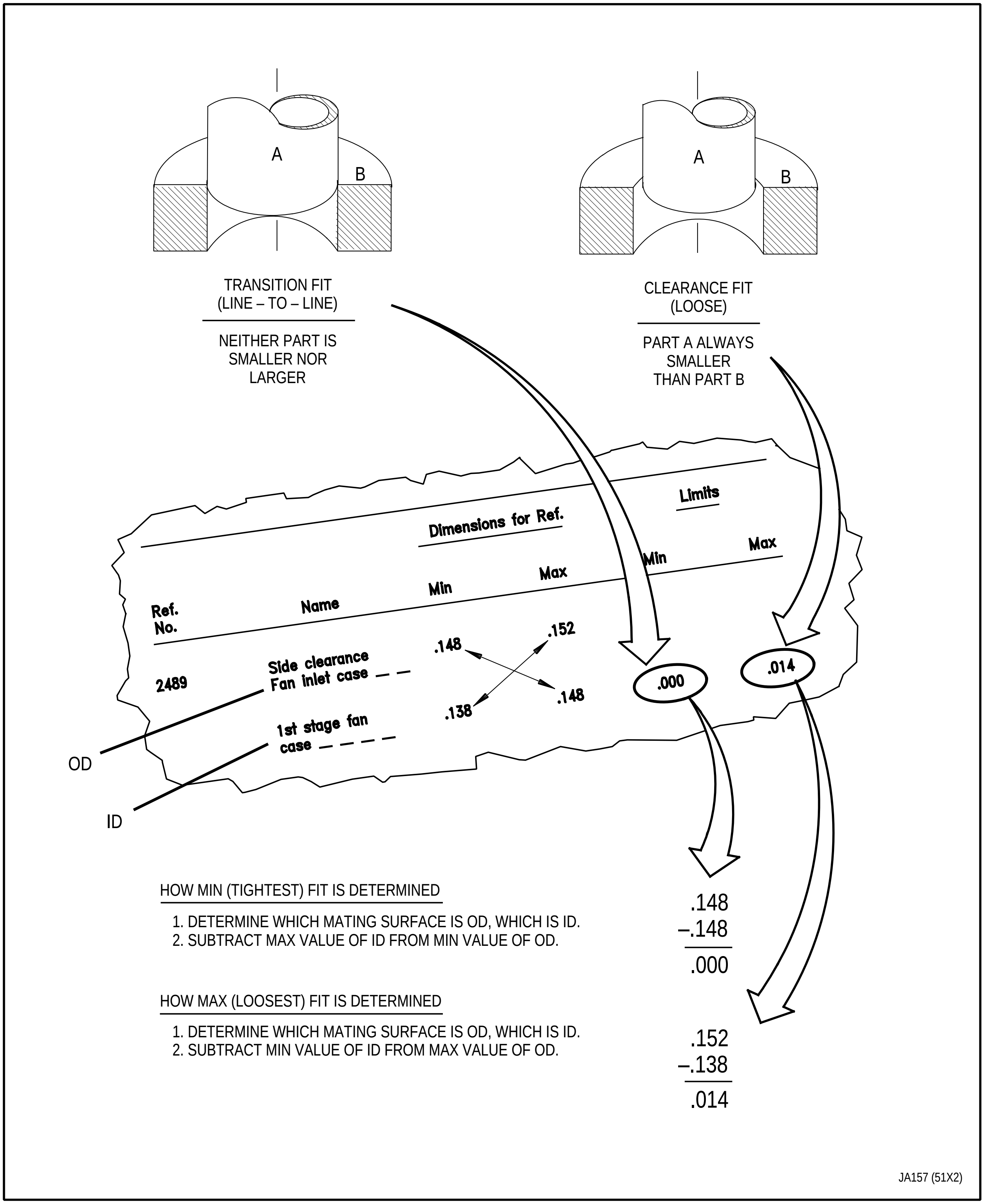


Figure 8. Table of Limits - How-To-Use (Sheet 3 of 5)

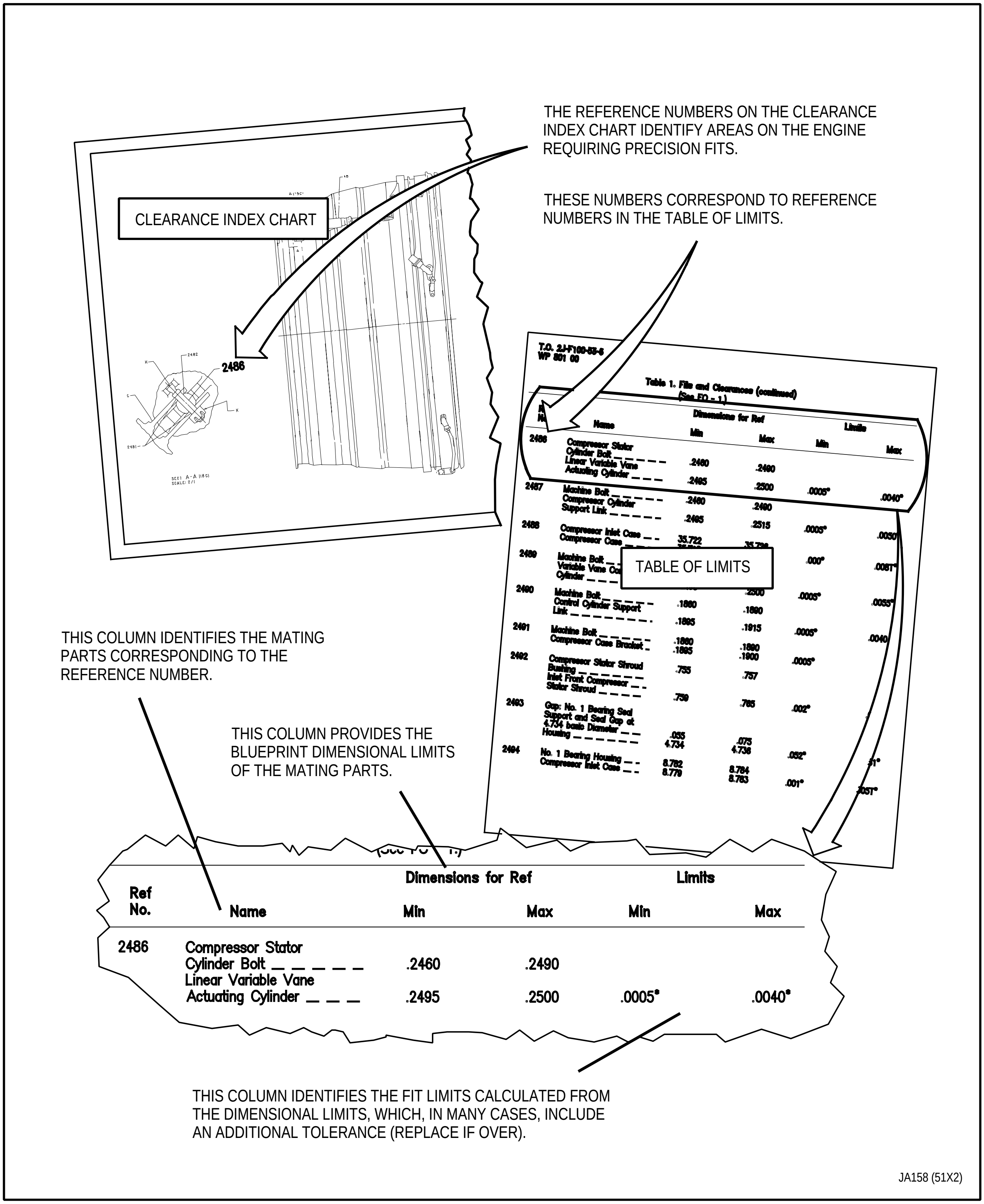


Figure 8. Table of Limits - How-To-Use (Sheet 4 of 5)

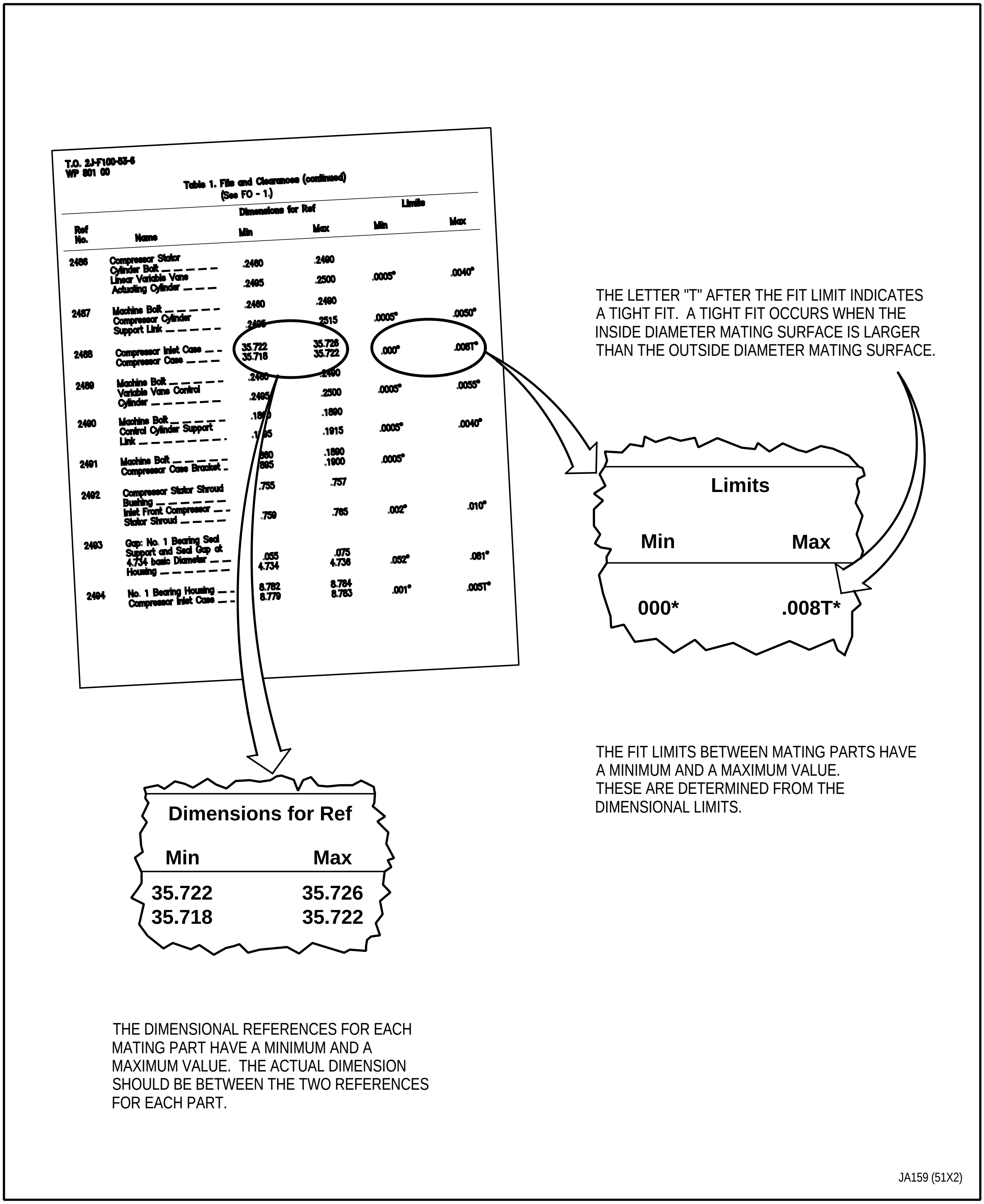


Figure 8. Table of Limits - How-To-Use (Sheet 5 of 5)

16. WARNINGS, CAUTIONS, AND NOTES.

a. When necessary, procedural text is supplemented by Warnings, Cautions, and Notes. These are defined as follows:

- WARNING: Operating procedure, practice, etc which could result in personal injury or loss of life if not correctly followed.
- CAUTION: Operating procedure, practice, etc which could result in damage or destruction of parts or equipment if not strictly observed.
- NOTE: Information provided for clarification of emphasis.

b. The Introduction and General Information manual contains a Safety Summary which lists all the warnings and cautions contained in the manual set.

17. TYPICAL PART NUMBER.

a. When the word TYPICAL precedes a part number, it means that this part number is one of several that may be used in this location.

b. By referring to this typical part number in the Illustrated Parts Breakdown (IPB) manual (T.O. 2J-F100-54), all part numbers applicable to this location can be found.

c. When a part number is used without the word TYPICAL it means that only that part number can be used.

17A. LOCALLY MANUFACTURED SUPPORT EQUIPMENT.

a. Locally manufactured support equipment may be manufactured by the using activity or by a local supplier.

b. Locally manufactured support equipment is listed in the Master Numerical List of Support Equipment in T.O.2J-F100-53-3, and the Applicable Support Equipment and Illustrated Support Equipment sections of maintenance WPs/SWPs.

c. Locally manufactured support equipment is identified in these WPs/SWPs by the prefix LM and a four digit number (LM 0123), or by the prefix LM followed by the PWA number (LM PWA 51203.)

d. When an LM tool is identified in a maintenance WP/SWP, all data required to make the tool will be found in T.O.2J-F100-53-3, WP 050 00.

18. SPECIFICATIONS.

a. Specification numbers listed in WP/SWPs are basic numbers and shall be interpreted to include all revisions and amendments.

b. Where specification number or vendor part number for consumable material is not available, the material will be referred to by its common or commercial name.

c. The specification number or vendor part number for such material will be furnished, when available, in subsequent changes to the manual set.

19. INSTRUCTION CONFLICTS.

a. Instructions in these WPs/SWPs shall be used in conjunction with general series technical orders and other directives.

b. In the event of conflict, the instructions in this manual set take precedence.

20. ENGINE DESIGN CHANGES.

a. The latest available information concerning parts and procedures will be provided in changes to this manual set.

21. ENGINE MODEL CONFIGURATION COVERAGE.

a. The depot maintenance manual set (T.O. 2J-F100-53-1 through T.O. 2J-F100-53-11 and T.O. 2J-F100-11-2) are for the F100-PW-229 engine only.

b. The effectivity by engine model appears on the title page of each work package.

22. TRADEMARKS.

a. The following words and acronyms are trademarks of United Technologies Corporation:

P&W ®

Pratt & Whitney ®

PW ®

PWA ®

23. ABBREVIATIONS.
(See Table 8.)

a. Abbreviations used in this manual set are in accordance with MIL-STD-12 where applicable.

b. Other abbreviations used in this manual set which are not covered by MIL-STD-12 are identified in table 8.

Table 8. List of Abbreviations

Abbreviation	Definition
A/B	- Augmentor
ADJ	- Adjustment
AE	- Area of augmentor nozzle exit
AFC	- Augmentor fuel control
AFP	- Augmentor fuel pump
AFPC	- Augmentor fuel pump controller
AFTO	- Air Force Technical Order
Aj	- Area of augmentor nozzle throat
AP	- Borescope inspection access ports, AP1 through AP7
AUG	- Augmentor
BX	- Bendix Energy Controls Division
CD CONT	- Chip detector continuity
CENC	- Convergent exhaust nozzle control
CIVV	- Compressor inlet variable vanes
CR-AL	- Chromel-alumel
DEEC	- Digital engine electronic control
EAU	- Engine analyzer unit
EDU	- Engine diagnostic unit
EETP	- Engine electrical terminal panel
EFH	- Engine flight hours
EHV	- Electro-hydraulic valve
EHSV	- Electro-hydraulic servo valve
EMD	- Engine manifold drain
ENP	- Exhaust nozzle position
EPR	- Engine pressure ratio - Pt6m/Pt2
Fn	- Net thrust
FO	- Foldout
FOD	- Foreign object damage
FTIT	- Fan turbine inlet temperature (Tt4.5)
FWD	- Forward
GG	- Gas generator (core engine)
GIT	- Ground idle thrust
GTAW-MA	- Gas tungsten arc weld - manual
Hg	- Mercury
HPC	- High pressure compressor
HPT	- High pressure turbine
HSD	- Hamilton Standard Division
HST	- Hot section time
Hz	- Hertz (cycles per second)
IAR	- Idle area reset
IGN	- Ignition
INC	- Increase
in HgA	- Inches of mercury, absolute
Intermediate (Mil)	- Intermediate power (Military)
ISTS	- Ignition system test set
JOAP	- Joint Oil Analysis Program
LCF	- Low cycle fatigue

Table 8. List of Abbreviations (continued)

Abbreviation	Definition
MAX AUG	- Engine power lever at 130° PLA (Segment II) (maximum augmentation)
MEK	- Methyl ethyl ketone
MFC	- Main fuel control
MIN AUG	- Engine power lever at 91° PLA (Segment I) position (minimum augmentation)
Mn	- Mach number
MOH	- Maximum operating hours
MOP	- Main oil pressure
MOT	- Main oil temperature
N1	- Front compressor speed (rpm)
N2	- Rear compressor speed (rpm)
N2C2	- N2 corrected to Tt2
OCM	- On-condition maintenance
P&D	- Pressurizing and dump valve
Pab	- Augmentor duct pressure
PAC	- Servo pressure to SOV
Pamb	- Ambient pressure
PAO	- Air pressure from SOV
Pb	- Burner pressure
Pfap	- Augmentor permission signal pressure
Pfext	- RCVV or CIVV extend pressure
Pfextm	- RCVV or CIVV extend pressure (BUC mode)
Pfextm	- RCVV or CIVV extend pressure (non BUC mode)
Pfmo	- Transfer request signal (BUC)
Pfo	- Fuel pump inlet pressure
Pfret	- RCVV or CIVV retract pressure
Pfretm	- RCVV or CIVV retract pressure (BUC mode)
Pfretp	- RCVV or CIVV retract pressure (non BUC mode)
Pfsbc	- Compressor start bleed closed pressure
Pfsbcm	- Compressor bleed valve closed pressure (BUC mode)
Pfsbcp	- Compressor bleed valve closed pressure (non BUC mode)
Pfsbop	- Compressor bleed valve open pressure (non BUC mode)
Pf1	- Main fuel pump boost stage discharge pressure
Pf1a	- Augmentor fuel pump discharge pressure
Pf2	- Main fuel pump vane discharge pressure
Pf2f	- MFP discharge pressure (filtered)
Pf2wm	- BUC inlet pressure, washfiltered, manual
Pf2sbcm	- BUC pressure, start bleed closed, manual
Pf3	- Main metered fuel pressure
Pf3a	- Augmentor metered fuel pressure
Pf4	- MFC main fuel control discharge pressure
Pf5a	- Augmentor outlet fuel pressure

Table 8. List of Abbreviations (continued)

Abbreviation	Definition
PLA	- Power lever angle; UC power lever shaft
PLAP	- Power lever angle prime; UC internal rate limited power lever
PMC	- Product Material Control
Pmb	- Main breather pressure
Popd	- Oil pump discharge pressure
Ps	- Static pressure
PSAP5	- Static pressure at AP5 borescope location
Pscv-4	- No. 4 bearing scavenge oil pressure
psid	- Pounds per square inch, differential
PSL	- Screen loss pressure (PSL = Pt2 - Pcell)
Pt	- Total pressure
Pt2	- Total pressure at fan inlet
Pt2.5	- Total pressure at fan discharge
Pt3	- Total pressure at rear compressor exit
Pt4	- Total pressure at combustor exit
Pt4.5	- Total pressure at fan turbine inlet
Pt5	- Total pressure at fan turbine exit
Pt6	- Total pressure at turbine discharge
Pt6m	- Fan turbine discharge air pressure (core engine and fan bypass air mixed)
Pt7	- Total pressure at exhaust nozzle throat
Pt8	- Total pressure at exhaust nozzle exit
R	- Pressure Ratio
RCVV	- Rear compressor variable vane
SA/ALC	- San Antonio Air Logistics Center
SCS	- Supervisory control system
SFPM	- Specific speed per minute
SGC	- Specific gravity corrected
SOV	- Shutoff Valve (BUC)
SOT4	- Scavenge oil temperature, No. 4 bearing compartment
SWP	- Subordinate work package
TBD	- To be determined
TBS	- To be supplied
Tf	- Fuel temperature
Tf(FM)	- Fuel temperature at flowmeter
Tfs	- Stored fuel temperature
TIG	- Tungsten inert gas (weld)
Tscv-4	- No. 4 bearing scavenge oil temperature

Table 8. List of Abbreviations (continued)

Abbreviation	Definition
Tt	- Total temperature
Tt2	- Total temperature at fan inlet
Tt2.5	- Total temperature at rear compressor inlet
Tt3	- Total temperature at rear compressor exit
Tt4	- Total temperature at combustor exit
Tt4.5	- TIT fan turbine inlet temperature
Tt5	- Total temperature at fan turbine exit
Tt6	- Total temperature at turbine discharge
Tt7	- Total temperature at exhaust nozzle throat
Tt8	- Total temperature at exhaust nozzle exit
UNJF	- Unified J fine thread
VDCH	- Diffuser case vibration, horizontal
VGBV	- Gearbox vibration, vertical
VGTV	- Variable geometry transfer valve
VIBR	- Vibration
VICV	- Fan inlet case vibration, vertical
Wae	- Engine airflow, lbs/sec
Wf	- Fuel flow
Wfgg	- Gas generator fuel flow, phr
Wftot	- Total fuel flow, phr
WP	- Work Package

24. F100 ENGINE WARRANTIES.

a. PURPOSE:

To define the three distinct engine warranties and establish procedures for the initiation and submittal of warranty claims by F100-PW-229 engine repair activities. These warranties are applicable to new production F100-PW-229 engines and modules.

b. DEFINITIONS:

Part I- Material & Workmanship and Design & Manufacturing

The contractor warrants that at the time of acceptance and for a period of three (3) years thereafter, each engine, module, LRU and non-LRU:

(i)shall be free from defects in material workmanship and (ii) shall be free from any condition, including nonconformances in design and manufacturing requirements which renders the engine unusable or unserviceable or causes it to operate other than in accordance with applicable Technical Orders.

Part II - Essential Performance Characteristics Warranty

The Contractor warrants that the performance of each engine delivered under this contract for a period of 4000 total accumulated cycles (TACs) shall not (1) be less than 98% of the intermediate thrust as set forth in specification; and (2) exceed 105% of the intermediate specific fuel consumption (SFC) as set forth in IPE Specification CP11350.

Part III - Shop Visit Rate Guarantee

The Contractor warrants the fleet-wide shop visit rate (SVR) per 1000 engine flying hours for engines. This guarantee is administered by ASD/YZWC.

NOTE

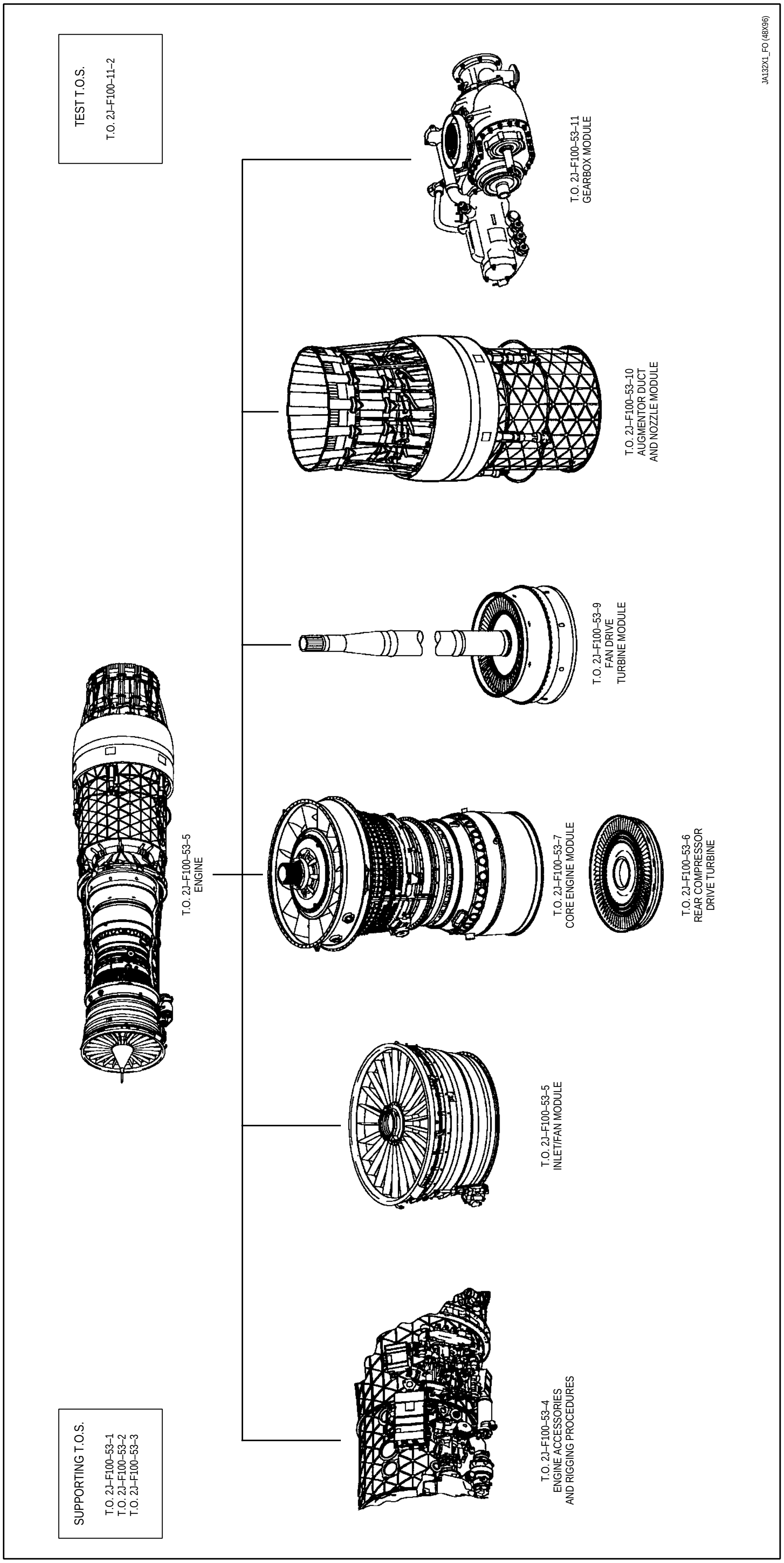
Parts, accessories, and modules are covered by this warranty, provided the engine they are installed on is within the warranty period (see AFTO Form 95).

c. WARRANTY DETERMINATION BY REPAIR ACTIVITY:

(1) Check AFTO Form 95 to determine if reparable engine, module or accessory is under warranty.

(2) Review reparable item records to determine operating time, engine cycles, or time from acceptance.

(3) If an engine, module, or accessory is still under warranty, initiate and process a Service Report (SR) following the procedure in T.O. 00-35D-54 and await disposition instructions from ASD/YZWC.



FO-1. Depot Maintenance Manual Set

WORK PACKAGE

MASTER LIST OF CONSUMABLE MATERIALS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 68

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	28	19 - 21	0	38	23
2 - 3	0	22	6	39	4
4	19	23	14	40 - 54	0
5	11	24	28	55	6
6	24	25 - 27	0	56	25
7 - 10	0	28	14	57	28
11	19	29	22	58	7
12	28	30	28	59	25
13	0	31 - 32	0	60	0
14	24	33	14	61	28
15	0	34	22	62 - 64	14
16	6	35	19	65	0
17	0	36	23	66	25
18	17	37	19	67 - 68	0

1. INTRODUCTION.

a. This WP contains a list of consumable materials which are referenced in WPs or SWPs. Government specifications are provided where available; otherwise, manufacturers' designations are supplied.

2. GENERAL.
(See Table 1.)

a. Table 1 lists consumable materials alphabetically, followed by trade designations, specifications, and names of vendors.

b. Vendors listed for consumable materials may not include all possible sources but are furnished for operator’s convenience.

c. The use of equivalent materials shall be at the operators’s discretion and responsibility.

Table 1. Consumable Materials

Nomenclature	Specification/Vendor Part Number	Vendor Address
Abrasive, aluminum oxide	Resinall Metalite 50xAl2O3 (Thin Joint) or Fastcut Resin Cloth A50x (Thin Joint)	Norton Co 1 New Bond St Worcester, MA 01606 The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Abrasive, silicon carbide	Resinall Durite 50xSiC (Thin Joint) or Fastcut Resin Cloth C50x (Thin Joint)	Norton Co 1 New Bond St Worcester, MA 01607 The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Acetic acid	O-A-76	-
Acetone (PMC 9008)	O-A-51	General Services Administration Washington, D.C.
Adhesive	H-H-66	R H Products Co., Inc. 207 South Street Boston, MA 02111
Adhesive, epoxy	Permabond 910	Eastman Chemical Products Inc P.O. Box 431 Kingsport, TN 37662
Adhesive, paper label	MMM-A-178	-
Adhesive, rapid curing, cyanoacrylate	MIL-A-46050, Type I, Class 1 or Loctite Superbonder 495	- Loctite Corp 705 N. Mountain Rd. Newington, CT 06111
Adhesive/sealant/filler (PWA 616) (PWA 36003)	 RTV-106 RTV-159	General Electric Co Silicone Products Dept Waterford, NY 12188
Adhesive/sealant/filler	RTV-108	General Electric Co Silicone Products Dept Waterford, NY 12188

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Adhesive/sealant/filler (PWA 617)	DC 3145 or RTV-159	Dow Corning Corp P.O. Box 1-M Midland, MI 48640 General Electric Co Silicone Products Dept Waterford, NY 12188
Adhesive/sealant, fluorosilicone (PWA 36052)	DC 730 RTV or DC Q4-2817 or FRV-1106	Dow Corning Corp Midland, MI 48640 General Electric Co Waterford, NY 12188
Adhesive/sealant, silicone RTV rubber	DC 3120	Dow Corning Corp Midland, MI 48640
Adhesive/sealant, silicone rubber (PWA 36047) (PN 4046892)	DC 93-076 (with 2 hour catalyst)	Dow Corning Corp Midland, MI 48640
Adhesive/sealant, silicone rubber (PWA 36057-1)	RTV 116	General Electric Silicone Products Dept. Waterford, NY 12188
Adhesive/sealant primer (PWA 556)	DC 1200	Dow Corning Corp Midland, MI 48640
Alcohol, denatured	O-E-760, Type III	-
Alcohol, isopropyl (PMC 9094)	TT-I-735	-
Alcohol, methyl	O-M-232	-
Alkali cleaner	Bendix 25-I	The Bendix Corp Instrument and Life Support Div 2734 Hickory Grove Rd P.O. Box 4508 Davenport, IA 52808
Alkali cleaner, carbon remover (PMC 1284)	Blue Gold Concentrate	Modern Chemical Inc P.O. Box 368 Jacksonville, AR 72076
Alkaline descaler, high temperature (PMC 1266)	Turco 4008 NP-2	Turco Products, Inc 61 Green St P.O. Box 602 Woodbridge, NJ 07095

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Alkaline descaler, low temperature (PMC 1268)	Delchem 2128A	Pennwalt Corp Metalprep Dept Three Parkway Philadelphia, PA 19102
	or No. 4008 NP-3	Purex Corp Turco Products Inc Div 61 Green St P.O. Box 602 Woodbridge, NJ 07095
	or Oakite Jet Strip Special	Oakite Products Inc 50 Valley Road Berkeley Heights, NJ 07922
	or Clarco JEC-1	Clarkson Laboratories Inc 1450 Ferry Ave Camden, NJ 08104
Alkaline rust remover (PMC 1269)	Ferlon	Wyandotte Chem Corp JB Ford Div 1532 Biddle Ave Wyandotte, MI 48192
Alkaline rust remover (SPMC 5)	Process 235L or Isoprep 177	MacDermid Inc. 245 Freight St. Waterbury, CT 06702
Alkaline rust remover (SPMC 7)	Turco 4181 or 4781-7	Purex Corp Turco Products Inc Div 61 Green St P.O. Box 602 Woodbridge, NJ 07095

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Alloy, Eutectic, low melting point Bismuth-Lead-Tin-Cadmium (PMC 5016)	Cerrobend	Cerro-Depasco Sales Corp 300 Park Ave New York, NY 10022
	or Quaternary Eutectic Alloy	United Refining and Smelting Co 3700 North Runge Ave Franklin Park, IL 60131
	or Asarco-L0158	Federated Metals 120 Broadway New York, NY 10005
	or Alloy 2505	Belmont Smelting and Refining Works Inc 330 Belmont Ave Brooklyn, NY 11207
	or Eutectic Alloy 158	Metal Specialties Inc 27930 Groesbeck St Rosenville, MI 48086
Alodine - See coating, chemical conversion		
Aluminum powder, pure, atomized	No. 400 Mesh	Reynolds Metals Co P.O. Box 1800 Campground Rd Louisville, KY 40501
Ammonium Acetate	-	-
Ammonium Hydroxide, concentrated (PMC 1667)	O-A-451, Type I	-
Bag, plastic, or equivalent	-	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Bag, sleeve and tubing	MIL-B-117	-
Barrier material 0.002 polyethylene preformed bags or sheet	PMC 4205 (Sheets) PMC 4215 (Bags)	Union Carbide Corp Plastics Div 270 Park Ave New York, NY 10017 or Monsanto Co P.O. Box 2130 Springfield, MA 01101
Barrier material greaseproofed flexible (waterproofed paper) (PMC 4190)	MIL-B-121, Type II Grade A, Class 1	-
Box, cardboard (18" x 12" x 6" high)	-	-
Binder, Alloy (PMC 1638)	Nicrobraze 300 Cement or Acryloid B-7	Wall Colmonoy Corp 19345 John R St Detroit, MI 48203 Rohm and Haas Co Independence Mall W Philadelphia, PA 19105
Brazing filler metal, gold - nickel (70 Au - 30 Ni) (PWA 718)	PWA 718: wire, sheet, strip, powder, viscous paste, or as ordered	Engelhard Minerals & Chemicals Corp Engelhard Industries Div 70 Wood Ave S Metro Park Plaza Iselin, NJ 08830 or GTE Products Corp Wesgo Division 77 Harbor Blvd Belmont, CA 94002

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Brazing filler metal, gold - nickel, high temperature (82 Au - 18 Ni) AMS 4787)	Paste 4 oz (124 grams) plastic syringe Fusion CKT-1742-854	Fusion Inc 4685 E 355th St Willoughly, OH 44094
	or Wesgo 2010	GTE Products Corp Wesgo Division 477 Harbor Blvd Belmont, CA 94002
	or AMS 4787 (PWA 698) wire, sheet, strip, powder, viscous paste, or as ordered	Engelhard Minerals & Chemicals Corp Engelhard Industries Div 700 Wood Ave S Metro Park Plaza Iselin, NJ 08830
Brazing filler metal, nickel - chromium - silicon (71 Ni - 19 Cr - 10 Si) (AMS 4782)	Transfer tape: Nicrobraz 30 or Extrudable paste 3.5 oz (109 grams) Nicrobraz 30 or Powder 16 oz (454 grams) Nicrobraz 30	Wall Colmonoy Corp 19345 John R Street Detroit, MI 48203
	or Amdry 100	Alloy metals Inc 501-T Executive Drive Troy, MI 48084
	or Brazing Transfer Tape	Vitta Corp 382 Danbury Rd Wilton, CT 06897

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Brazing filler metal, silver - cadmium - zinc copper (50 Ag - 18 Cd - 16.5 Zn - 15.5 Cu) (AMS 4770)	AMS 4770 wire	Handy and Harman 850 Third Ave New York, NY 10022
Brazing filler metal, silver - copper - nickel (56 Ag - 42 Cu - 2.0 Ni) (AMS 4765) (PWA 707)	AMS 4765 (PWA 707) wire, powder, foil	Handy and Harman 850 Third Ave New York, NY 10022 or Engelhard Minerals & Chemicals Corp Engelhard Industries Div 70 Wood Ave S Metro Park Plaza Iselin, NJ 08830 or GTE Products Corp Wesgo Division 477 Harbor Blvd Belmont, CA 94002
	Extrudable paste in 3.5 oz (109 grams) plastic cartridge Fusion CKG 4765-850 or	Fusion Inc 4658 E 355th St Willoughly, OH 44094
	Wesgo 9684	GTE Products Corp Wesgo Division 477 Harbor Blvd Belmont, CA 94002

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Brazing filler metal, silver - copper - zinc - nickel (54 Ag - 40 Cu - 5.0 Zn - 1.0 Ni) (AMS 4772)	AMS 4772 wire	Handy and Harman 850 Third Ave New York, NY 10022 or Engelhard Minerals & Chemicals Corp Engelhard Industries Div 70 Wood Ave S Metro Park Plaza Iselin, NJ 08830 or Krohn Industries Inc 303 Veterans Blvd Carlstadt, NJ 07072
Brazing filler metal, silver - palladium - copper(54 Ag - 25 Pd - 21 Cu) (PWA 706)	Paste 4 oz (124 grams) plastic syringe Fusion CKT-1740-852 or Wesgo Palcusil 25 or PWA 706: Wire, sheet, strip, powder, viscous paste or as ordered	Fusion Inc 4658 E 355th St Willoughly, OH 44094 GTE Products Corp Wesgo Division 477 Harbor Blvd Belmont, CA 94002 Handy and Harman 850 Third Ave New York, NY 10022 or Krohn Industries Inc 303 Veterans Blvd Carlstadt, NJ 07072
Brazing filler metal, silver - palladium - copper - nickel (48.5 Ag - 22.5 Pd - 19 Cu 10 Ni) (PWA 715)	PWA 715: Wire, sheet, strip, powder, viscous paste, or as ordered	Krohn Industries Inc 303 Veterans Blvd Carlstadt, NJ 07072
Brush, acid swabbing	H-B-643	American Fuel Cell & Coated Fabrics Co. 601 Firestone Dr., 887 Magnolia, AR 71753 GSA Crystal Mall Bldg 4 1941 Jefferson Davis Hwy Washington, DC 20406
Brush, bristle	-	Solo-Horton Brush Co Inc 940 8th Ave New York, NY 10019

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Brush,nonmetallic soft	H-B-1490/3-TI	McMaster Carr Supply Co 600 County Line Rd Elmhurst, IL 60126
Brush, wire	-	Osborn Mfg Corp 5401 Hamilton Ave Dept T Cleveland, OH 44114
Cable, safety, kit - (corrosion and heat resistant steel) - UNS S323100	AS3510-0318K	Daniels Mfg Corp 526 Thorpe Rd Orlando, FL 32824
Cellulose nitrate solution (PMC 9737)	L-1423	The Voltax Co Inc 460 Bostwick Ave P.O. Box 3365 Bridgeport, CT 06605
Cheesecloth, unsized	PWA GA 100-11 or CCC-C-440	John R. Lyman Co 60 Depot St Chicopee, MA 01013
Cleaner, stripping bath	Cee-Bee A227D	Mc Gean - Rohco Inc Rohco Division 9520 E. CeeBee Dr Downey, CA 90241
Cleaner, emulsion	P-C-444, Type I or Emul-Klene (Turco 3878) or Van Straaten 3201	- Purex Corp Turco Products Inc Div 61 Green St P.O. Box 602 Woodbridge, NJ 07095 Van Straaten Chemical Co 630 W Washington St Chicago, IL 60606
Cleaner - immersion type, concentrate (PMC 1664)	Liquid Immersion Cleaner (LIC) or 90 Cleaner Inhibitor	Lectroetch Co 14925 Elderwood Ave E. Cleveland, OH 44112 Monode Inc 13409 St Clair Ave Cleveland, OH 44110
Cleaning fluid - Sparkleen	Cat. No. 04320	Fisher Scientific Co 1600-T Parkway View Dr Pittsburg, PA 15205

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Cleaner/Neutralizer (PMC 1658)	1 Cleaner	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094
	or 15-200 Cleaner and Inhibitor	Monode Inc 13409 St Clair Ave Cleveland, OH 44110
	or 2 Cleaner	Lectroetch Co 14925 Elderwood Ave E Cleveland, OH 44112
Cleaner/neutralizer (PMC 1659)	2 Cleaner	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094
	or 3 Cleaner	Lectroetch Co 14925 Elderwood Ave E. Cleveland, OH 44112
	or 15 Cleaner/Inhibitor	Monode Inc 13409 St Clair Ave Cleveland, OH 44110
Cleaner, dye penetrant, visible	Spotcheck SKC-NF	Magnaflux Corp 7300 W. Lawrence Ave Chicago, IL 60656
	or Remover K-410E	Uresco Ardrox 10603 Midway Ave Cerritos, CA 90701

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Cloth, abrasive, 120 grit	Resinall Metalite 120x Al2O3 Rolls 1.5 inches (3.8 cm) wide	Norton Co. 1 New Bond St. Worcester, MA 01606
Cloth, abrasive, aluminum oxide 320 grit	01830-4	Norton Co. 1 New Bond St. Worcester, MA 01606
Cloth, abrasive, silicon carbide	120, 400 grit	The Carborundum Co. P.O. Box 337 Buffalo Ave. Niagara Falls, NY 14302
Cloth, abrasive, crocus	A-A-1206	-
Cloth, Cleaning	Rymple cloth - 301	Kendall Co., The Fiber Products Div. 1 Federal St. Boston, MA 02110
Cloth, dry, lint-free	-	-
Cloth, emery	-	Norton Co. 1 New Bond St. Worcester, MA 01606 or The Carborundum Co. P.O. Box 337 Buffalo Ave. Niagara Falls, NY 14302
Cloth, silk or nylon	-	-
Cloth, polishing	Norton 4/0	Norton Co. 1 New Bond St. Worcester, MA 01606
Coating, aluminum oxide (PWA 595)	SermeTel W	Sermatech Intl Inc Metals Division 155 S. Limerick Rd. Limerick, PA 19468
Coating, aluminum - zinc touch-up catalyst	SermeTel 273	Sermatech Intl Inc. Metals Division 155 S. Limerick Rd. Limerick, PA 19468
Coating, aluminum - zinc touch-up for SermeTel W, corrosion resistant (PWA 548)	SermeTel 249	Sermatech Intl Inc. Metals Division 155 S. Limerick Rd. Limerick, PA 19468

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Coating, Boron Nitride (PMC 2264)	Type S-4	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Coating, chemical conversion	MIL-C-5541	-
Coating, dry film lubricant (PWA 298)	Drilube 805N or Everlube 811	Drilube Company 711 West Broadway Glendale, CA 91204 E/M Lubricants Inc West Lafayette, IN 47906
Coating, plastic	Krylon Crystal Clear	Borden Inc Dept CP 180 E. Broad St Columbus, OH 43215
Coating, resin (clear)	E-2477	Miller Protective Coatings Inc P.O. Box 641 260 Compco Rd South Westport, CT 06880
Coating, Teflon finish (AMS 2515)	No. 852-201	E I DuPont De Nemours & Co Inc Fabrics & Finishes Dept 308 E. Lancaster Ave Wynnewood, PA 19036
Coating, touch-up (PWA 36054)	SermeTel 196	Sermatech Intl Inc Metals Division 155 S. Limerick Rd Limerick, PA 19468
Compound, abrasive, wet (PMC 3085)	NVB 200 or 200 NE	Vapor Blast Mfg Co 3025 W. Atkinson Ave Milwaukee, WI 53209 Wheelabrator-Fry Inc Mishawaka, IN 46544

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, aluminum filler (PMC 1681)	Devcon F	Devcon Corp Endicott St Danvers, MA 01923
Compound, antigalling (PWA 474)	LS 2065	Graphite Products Corp 15 Warren - Sharon Road Brookfield, OH 44403
Compound, antigalling (PWA 550)	Hi-T 650 or Lubri-Bond HT	Sandstrom Products Co 224 Main St Port Byron, IL 61275
Compound, antigalling (PWA 559)	Fel-Pro C-652	Felt Products Mfg Co Fel-Pro Inc Div 7450 N. McCormick Blvd Skokie, IL 60076
Compound, antigalling (PWA 36035)	Fel-Pro C-300	Felt Products Mfg Co Fel-Pro Inc Div, Box C1103 7450 N. McCormick Blvd Skokie, IL 60076
	or (for fasteners only) Kaylube 3	Kaynar Mfg Co, Inc 800 South St College Blvd Fullertown, CA 92631
Compound, antigalling (PMC 9940) or (PWA 36001)	Silver Goop	Crawford Fitting Co 29500 Solon Rd Solon, OH 44139
Compound, antigalling (PWA 36053-3)	Loctite nickel antiseize 771	Loctite Corp 999 N. Mountain Rd Newington, CT 06111
Compound, antigalling (PWA 36545)	Everlube Esnalube 382	E/M Lubricants, Inc. 6940 Farmdale Ave. N. Hollywood, CA 91605

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, antigalling, antigalling (PMC 9936)	Parker Thread Lube	Fleet Supply 869 E. 148th St Cleveland, OH 44110
Compound, antisolidifying (PMC 1612)	Anaset or No-Pac	Wheelabrator-Frye Inc Mishawaka, IN 46544 Vapor Blast Mfg Co 3025 W. Atkinson Ave Milwaukee, WI 53209
Compound, carbon removing and paint stripping (cold solvent type) (PMC 9047) (PMC 9031) (PMC 9084)	P-C-111 or Super-Carb or Penetone No. 423 or P-1075	Purex Corp Turco Products Inc 61 Green St P.O. Box 602 Woodbridge, NJ 07095 Amerace Corp Penetone Div P.O. Box 127 74 Hudson Ave Tenafly, NJ 07670 Wyandotte Chem Corp J B Ford Div 1532 Biddle Ave Wyandotte, MI 48192
Compound, corrosion preventive	MIL-C-0081309, Type I	-
Compound, corrosion removing	MIL-C-14460 Type I	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, corrosion preventive, fingerprint removing (PMC 9118)	MIL-C-15074 or AMS 3065	-
Compound, corrosion preventive, solvent cutback, cold application	MIL-C-16173	-
Compound, corrosion preventive petrolatum, hot application (PMC 9109)	MIL-C-11796, Class 3	-
Compound, diamond	No. 9	Amplex Corporation 100 Britton Dr Bloomfield, CT 06002 or Buehler Ltd P.O. Box 1 41 Waukegan Rd Lake Bluff, IL 60044
Compound, dielectric	MIL-S-8660C	-
Compound, hot tank cleaner	Cee-Bee C-46	McGean Chem Co, Inc 9520 E. Cee Bee Drive Downey, CA 90341
Compound, lapping	Corundum 302 1/2 38-500 38-900 38-1200	U. S. Products Co 518 Melwood Ave Pittsburgh, PA 15213
Compound, lapping (PMC 3151)	1800 (12-1/2 microns grit size) or No. 125	Crane Packing Co 6400 W. Oakton St Morton Grove, IL 60053 Mosher Mfg Co, Inc 15 Exchange St P.O. Box 177 Chicopee, MA 01014
Compound, lapping 400 grit	AA-400-V7-OS	The Carborundum Co. Buffalo Ave. P.O. Box 337 Niagara Falls, NY 14302

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, lapping, diamond (PMC 3129-1) (PMC 3129-2)	3 Micron diamond or 6 micron diamond or Metadi, No. 40-6142	Elgin Nat Watch Co Precision Prods Parts Div 366 Bluff City Blvd Elgin, IL 60129 or Mark V Lab Inc Newgate Rd P.O. Box 310 East Granby, CT 06026
Compound, lapping, silicon carbide (PMC 3014)	Clover B (240 grain size)	Clover Mfg Co 137 Woodward Ave Norwalk, CT 06852
Compound, lubricating, dry film (PWA 585)	Molykote X-15	Dow Corning Corp Lubricants Plant 45 Commerce Drive Trumbull CT 06601
Compound, lubricating, antiscuffing and antiseizing	Molykote G-N	Dow Corning Corp Lubricants Plant 45 Commerce Drive Trumbull CT 06601
Compound, metal cutting, oil type (PMC 9201	Fanox N-33 or Blend of 97% PMC 9002 mineral seal oil, with 3% PMC 9219 synthetic fatty oil	Exxon Co USA P.O. Box 2180 Houston, TX 77001

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, metal cutting, water type (PMC 9325)	Dasco 1773	D.A. Stuart Oil Co Ltd 2727 S. Troy St Chicago, IL 60623
	or Mobilmet S-127	Mobil Oil Corp 150 E. 42nd St New York, NY 10017
	or Emulsion 51	Sun Oil Co of Pennsylvania 1608 Walnut St Philadelphia, PA 19103
	or 5937	Shell Oil Co P.O. Box 2463 1 Shell Plaza Houston, TX 77001
Compound, molybdenum, disulfide	Kaylube 3 (PWA 36545)	Kaynar Mfg Co 800 S. State College Blvd Fullerton, CA 92631
	or Everlube 382	E/M Lubricants P.O. Box 2200 West Lafayette, IN 47906
Compound, polishing greaseless, 120 grit (coarse) (PMC 3022)	Lea Grade L	Lea Mfg Co 237 E Aurora St P.O. Box 71 Waterbury, CT 06720
Compound, retaining (adhesive)	PWA 549, Type II (PWA 612769) MIL-R-46082, Type II, Loctite 40	Loctite Corp 705 No. Mountain Rd Newington, CT 06111
Compound, sealing	PN 4024767	United Technologies Pratt & Whitney Government Engines & Space Propulsion P.O. Box 109600 West Palm Beach, FL 33410-9600

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, sealing, (jointing) (PWA 36000-2) (PWA 36000-3) (PWA 36000-4)	Hylomar Pl-32 or SQ 32 heavy grade medium grade light grade	Van Dusen Aircraft Supplied 5643 N.W. 36th St Miami Springs, FL 33166 or Raymac Associates Inc Hamshire, TX 77622
Compound, sealing (PMC 9931) (PWA 36002) (PMC 9925)	MIL-S-45180, Type III or Permatex Form-a-gasket 2 or Permatex Aviation Form-a-gasket 3 or	Permatex Corp P.O. Box 1350 Flagler Ct Bldg West Palm Beach, FL 33042
(PMC 9926)	Dow Corning No. 4 or	Dow Corning Corp Lubricants Plant 45 Commerce De Trumbull, CT 06601
(PMC 9929)	Parker Sealube	Parker Hannifen Corp Parker Tube Fitting Div 17325 Euclid Ave Cleveland, OH 44112
Compound, silicone rubber fluid (PMC 1809)	RTV-21	General Electric Co Silicone Products Dept Waterford, NY 12188

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Compound, Stop-off Low melting point alloy (PMC 1645)	Babbitrite	Babbitrite Prod Co 329 E. Lake Ave Peoria, IL 61614
Container, plastic (1 pint capacity)	-	-
Container, plastic (2 gallon capacity)	-	-
Container, plastic (5 gallon capacity)	-	-
Coolant, metal cutting, water type (PMC 9320)	Hocut 3210 or Castrol 9320 or Van Straaten 700	E.F. Houghton & Co. P.O. Box 930 Valley Forge, PA 19482 Castrol Industrial East, Inc. 775 Louis Drive Warminister, PA 18974 Van Straaten Corp. 630 W. Washington Blvd. Chicago, IL 60606
Coolant, Nitrite Amine Type (PMC 9313)	Trim-Ti Grind or International No. 48	Master Chem Co 13 N. Huron Toledo, OH 43604 International Chem Co 2628 No. Mascher St Philadelphia, PA 19133
Coolant, oil type (PMC 9259)	Vantrol 541-2M or X74-21	Van Straaten Chem Co 630 W. Washington St Chicago IL 60606 Reilly Whiteman Inc Washington & Righter Sts Conshohocken, PA 19428
Copper Sulfate, powder (PMC 1308)	O-C-828	-
Corrosion inhibitor (PMC 9332)	X74-26A water conditioner	Reilly-Whiteman Inc 801-A Washington Street Conshohocken, PA 19428

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Cotton swab	-	-
Crayon	Phano No. 71 Red	Joseph Dixon Crucible Co P.O. Box 472 167 Wayne St Jersey City, NJ 07303
Crayon, metal marking (hard)	Colorbrite Silver No. 2101 or Anadel No. 1936 or Color-Tex Silver No. 1843	Eberhard Faber Co Crestwood Rd Wilkes-Barre, PA 18707 Joseph Dixon Crucible Co P.O. Box 472 167 Wayne St Jersey City, NJ 07303 General Pencil Co 67 Fleet St Jersey City, NJ 07306
Curing solution for PWA 568 primer	Desoto 910-357 Solvent 020 X 324	Desoto Inc Garland, TX 75040
Curing solution for PWA 569 enamel	Desoto 910-465	Desoto Inc Garland, TX 75040
Degreaser	FREON (2702 spray aerosol for electronics)	-
Desiccant (bags)	MIL-D-3464	-
Diaphragm material	GC 10-31	Programmed Composites 380 Cliffwood Park Brea, CA 92621
Dimethylgyloxime	-	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Dry Ice (Solid CO2)	-	Cardox Corp.
Dye, layout (PMC 4062) or Ink, Carters’s black or Ink, Dykem or Ink, Volger’s Opaque black	Micro-Supreme (Purple) KX425 (Black) KXX122 (White) - 	Mi Chrome & Chem Co 8615 Grinnell Ave Detroit, MI 48213 The Carter’s Ink Co Cambridge, MA 02141 Dykem Co St Louis MO 63166 Volger’s Ink Mfrs Elizabeth, NJ 07207
Electrolyte - marking fluid (PMC 1655)	P-16 or C-10 or LNC-2	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094 Monode Inc 13409 St Clair Ave Cleveland, OH 44110 Lectroetch Co 14925 Elderwood Ave East Cleveland, OH 44112

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Electrolyte - marking fluid (PMC 1650)	SC-35	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094
	or F-10	Monode Inc 13409 St Clair Ave Cleveland, OH 44110
	or 2611A	Lectroetch Co 14925 Elderwood Ave East Cleveland, OH 44112
Electrolyte - marking fluid (PMC 1653)	P-14	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094
	or B-10	Monode Inc 13409 St Clair Ave Cleveland, OH 44110
	or 220A	Lectroetch Co 14925 Elderwood Ave East Cleveland, OH 44112
Enamel, alkyd gloss (gray or black) (FED-STD-595, No. 16473 gray or No. 17038 black)	TT-E-489	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Enamel, aluminum-silicone, high-baking (PWA 578)	Formula 7897, Type I	Pratt & Lambert Inc :nL 75 Tonawanda St P.O. Box 22 Buffalo, NY 14240
	or Formula 612-706, Type 2	E.I. Dupont De Nemours & Co Inc Fabric & Finishes Dept 308 E. Lancaster Ave Wynnewood, PA 19036
	or Formula LB-304	I-Sis Chemicals Inc P.O. Box 4777 9 Viaduct Rd Springdale, CT 06907
	or Type I (to PWA 578)	Miller Protective Coatings Inc P.O. Box 641 260 Compo Rd South Westport, CT 06880
Enamel, glyceryl phthalate, black baking (AMS 3120)	-	Egyptian Lacquer Mfg Co P.O. Box 444-T Newark, NJ 07102 or Lowe Bros Co 101 Prospect Ave N.W. P.O. Box 6027 Cleveland, OH 44101 or Pratt & Lambert Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 14240

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Enamel, glyceryl phthalate, black baking (AMS 3120) (continued)	Compound M-964-B	Guardsman Chemicals 1350-T Steele Ave S.W. Grand Rapids, MI 49507 or Duralac Chem Corp 84-T Lister Ave Newark, NJ 07105 or The Voltax Co Inc 460 Bostwick Ave P.O. Box 3365 Bridgeport, CT 06605
Enamel, glyceryl phthalate, engine gray (AMS 3125)	-	Egyptian Lacquer Mfg Co P.O. Box 444-T Newark, NJ 07102 or Lowe Bros Co 101 Prospect Ave N.W. P.O. Box 6027 Cleveland, OH 44101 or Pratt & Lambert Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 14240 or
	Compound E-1613A	The Voltax Co Inc 460 Bostwick Ave P.O. Box 3365 Bridgeport, CT 06605 or PPG Industries Inc Coatings & Resins Div One Gateway Center Pittsburgh, PA 15222
Enamel, aluminized epoxy (PWA 569)	Enamel base 529-300	Desoto Inc Garland, TX 75040
Enamel, alkyd-silicone, gray (PWA 594)	Glyptal S-1193 NSNKZ-8010-00-200-3259	General Electric Co Silicone Products Div Waterford, NY 12188

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Fabric, glass	Bleeder Lease "C"	Airtech International 2542 E. Delamo Blvd. Carson, CA 90749
Felt bob	-	-
Fiber, ceramic	Fiberfrax bulk fiber	The Carborundum Co Refractories & Electronics Div Ceramic Fiber Plant P.O. Box 808 Niagara Falls, NY 14302
Film, KAPTON	Thermalimide 0.002 inch	Airtech International 2542 E. Delamo Blvd. Carson, CA 90749
Film, polyester	L-P-377, Type 1	-
Film, polyethylene	L-P-378	-
Film, TEFLON	Release Ease 0.003 inch 234 TFP(porous) 234 TFNP(non-porous)	Airtech International 2542 E. Delamo Blvd. Carson, CA 90749
Finish, high temperature, acidic, water base, inorganic, oxidation inhibitor (PWA 561)	SermaSeal 570A	Sermatech Intl Inc Metals Division 155 S. Limerick Rd Limerick, PA 19468
Fluid, calibrating	MIL-C-7024	-
Fluid, cutting and grinding, water-type (PMC 9317)	X1690	Quaker Chem Products Corp Lime, Elm & Sandy Sts Conshohocken, PA 19428
Fluid, leak check	MIL-L-25567	-
Fluorescent penetrant (PMC 4350-2)	Zyglo ZL-15B	Magnaflux Corp 7300 W. Lawrence Ave Chicago IL 60656
Flux, low temperature silver brazing	AMS 3410 O-F-499	Handy & Harman 850 Third Ave New York, NY 10022
Flux, silver brazing, high temperature (AMS 3411)		Engelhard Minerals & Chemicals Corp Engelhard Industries Div 70 Wood Ave S Metro Park Plaza Iselin, NJ 08830 or Handy & Harman 850 Third Ave New York, NY 10022
Flux, high temperature (PWA 809)	Hi-Temp White Flux	Handy & Harman 850 Third Ave New York, NY 10022

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Freon solvent See Trichlorotrifluoroethane		

NOTE

Primary fuel, NATO F-40, may not contain MIL-I-25017 corrosion inhibitor at some locations. Alternate fuels Jet A, Jet A-1, Jet B, and NATO F-35, do not contain MIL-I-25017 corrosion inhibitor. NATO F-34, NATO F-43, and NATO F-44 may or may not contain MIL-I-25017 corrosion inhibitors. Duration of engine operation without corrosion inhibitor is not limited.

Nomenclature	Specification/Vendor Part Number	Vendor Address
Fuel, jet	Primary: MIL-T-5624, Grade JP-4 (NATO F-40) Alternates: MIL-T-83133, Grade JP-8 MIL-T-5624, Grade JP-5 ASTM-D-1655 (Jet A, Jet A-1, or Jet B) NATO F-34, F-35, F-43, or F-44	-
Glass Bead, 0.0015 to 0.0029 inch diameter - 270 mesh (PMC 3084)	MIL-G-9954 Size 13	GSA Washington, D.C.
Gloves, cotton, lint-free	-	-
Graphite, colloidal, alcoholic dispersion paste (PMC 9525)	DAG 154	Acheson Industries Inc. Acheson Colloids Co. Div. 1635 Washington St. Port Huron, MI 48060
Grease, aircraft and instrument	MIL-G-23827	GSA Washington, D.C.
Grease, extreme pressure (PMC 9630)	Lubriplate 1200-2	Fiske Bros Refining Co. Lockwood & Ryan Sts Newark, NJ 07105

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Grease, aircraft, general purpose	MIL-G-81322	-
Grease, high temperature (Bentonite-type) (PMC 9631)	Plastilube No. 3 or NSN 9150-00-141-4481 Plastilube Moly No. 3	Parr Inc 18400 Syracuse Ave Cleveland, OH 44101
Grit, aluminum oxide, No. 60 to No. 80	Blastite BT No. 60 to 80	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Grit, aluminum oxide, No. 150 (PMC 3155)	Blastite BT No. 150 or Arrow blast No. 150	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302 Norton Co 1 New Bond St Worcester, MA 01606
Grit, aluminum oxide, 280-320 mesh (PMC 3052-8)	Polishing grain RHT or Alundum 320 EIB	Exolon Co 1000 E. Niagara St Tonawanda, NY 14150 Norton Co 1 New Bond St Worcester, MA 01606
Grit, aluminum oxide, 240-400 mesh	SAE grain size 240 Aloxite grain 240 WPM or Alundum grain 240 EIB	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302 Norton Co 1 New Bond St Worcester, MA 01606

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Grit, aluminum oxide, 90 mesh (PMC 3043)	Blastite BT No. 90	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
	or Arrowblast No. 90 or Dynablast No. 90	Norton Co 1 New Bond St Worcester, MA 01606
	or Fastblast No. 90	Exolon Co 1000 E. Niagara St Tonawanda, NY 14150
Grit, aluminum oxide, (PMC 3046)	Blastite BT No. 240	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
	or Fastblast No. 240	Exolon Co 1000 E. Niagara St Tonawanda, NY 14150
	or Arrowblast No. 240	Norton Co 1 New Bond St Worcester, MA 01606
Grit, aluminum oxide	No. 30 Arrowblast No. 60 Arrowblast	Norton Co 1 New Bond St Worcester, MA 01606
	or No. 30 Fastblast No. 60 Fastblast	Exolon Co 1000 E. Niagara St Tonawanda, NY 14150

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Grit, silicon carbide	Silicon carbide 30 to 100	Norton Co 1 New Bond St Worcester, MA 01606 or The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Grit, silicon carbide 60 mesh	Silicon carbide 60 or 60A	Norton Co 1 New Bond St Worcester, MA 01606 The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302
Grit, silicon carbide (PMC 3053-38)	Silicon carbide 320	The Carborundum Co Buffalo Ave P.O. Box 337 Niagara Falls, NY 14302 or Norton Co 1 New Bond St Worcester, MA 01606 or Dresser Industries Inc General Abrasive Div 2000-T College Ave Niagara Falls, NY 14305 or Washington Mills Abrasive Co North Main St North Grafton, MA 01536

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Grit, soft (PMC 3010)	Nielco Shell Clean No. 12/20 or Temper-Tex HW-20 or Turco Carboblast	John R. Nielsen & Sons Inc 260 Chapel Rd P.O. Box 132 S. Windsor, CT 06074 Southeastern Reduction Co Valdosta, GA 31601 Purex Corp Turco Products Inc Div 61 Green St P.O. Box 602 Woodbridge, NJ 07095
Grit, steel	MIL-S-851	-
Grit, zirconium silicate No. 120	Zirconite No. 120	Corning Glass Works 31501 Solon Rd Solon, OH 44139
Hardener, silicone rubber	Nuocure 28	Tenneco Chemicals Inc Nuodex Div P.O. Box 2 Piscataway, NJ 08854
Heater blanket	CRS3010, single ply, silicone, 220V, 350W with 16 inch leads	Compositech Eng. P.O. Box 9327 Riviera Beach, FL 33419
Hydrochloric acid, technical (muriatic) (PMC 1002)	O-H-765	-
Hydrochloric acid, inhibited (PMC 1011)	PM 90	Pennwalt Corp Metalprep Dept
Inhibitor for hydrochloric (muriatic) acid (PMC 1015)	Rodine XL 1090A	Anchem Products Inc P.O. Box 33 Ambler, PA 19002
Ink, fast drying	400-1 (black) 400-2 (red) 400-7 (purple)	Tex-Rite Products Co Detroit, MI 48232

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Ink, marking	KX 425 (black)	Dykem Company 8501 Delport Drive St Louis, MO 63114
Ink marking	No. 451 (black)	The Carter's Ink Co 275-T Wyman St Waltham, MA 02154
Ink, metal marking (PMC 4057-1) (PMC 4057-2)	No. 977-9 (black) No. 977-9 (white)	State Stamp Works 226 South St West Hartford, CT 06110
Ink, opaque black	Volger's Opaque Black	Volger's Ink Mfgrs Elizabeth, NJ 07207
Ink, white	KXX 122	Dykem Co St Louis, MO 63166
Lacquer, Stop-OFF (PMC 9701)	No. 66X2866A	The Stanley Works Stanchem Inc 401 Berlin St E. Berlin, CT 06023
Lacquer, Stop-Off for Alkali Immersion (PMC 9704	Micromask Stop-Off Lacquer	Mi Chrome & Chem Co 8615 Grinnell Ave Detroit, MI 48213
Lockwire (0.020 inch diameter) (0.025 inch diameter) (0.032 inch diameter) (0.040 inch diameter) (0.051 inch diameter)	 MS9226-02 MS9226-03 MS9226-04 MS9226-05 MS9226-06	GSA
Lubricant, bolt SAE 250 (PMC 9866)	Kendall All-Oil	Kendall Refining Co Bradford, PA 16701
Lubricant, cleaning and preserving	MIL-L-63460	-
Lubricant, corrosion inhibiting	Extreme Duty Silicone (PN 03030) NSN 6850-01-265-3115	CRC Chemicals USA 885 Louis Drive Warminster, PA 18974
Lubricant, corrosion removing	NSN 6850-00-050-0659 CRC 3-36 (PN 03005)	CRC Chemicals USA 885 Louis Drive Warminster, PA 18974

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Lubricant, grease	Braycote 602 or Braycote 615 or Braycote 620 or Molycote HP-300	Burmah-Castrol Inc Suite 230 16815 Von Karman Ave, Irvine, CA 92714 Dow Corning Corp Midland, MI 48686
Lubricant, penetrant rust inhibitor (PWA 36043) (PWA 9125)	WD-40 or Rust Pel 1000 or CRC 5-56 or 22DA	WD-40 Co 1061 Cudahy Place San Diego, CA 92110 Mitchell-Bradford Chem Co Wampus Lane Milford, CT 06460 CRC Chemicals 885-T Louis Dr Warminster, PA 18974 Loctite Corp 705 N. Mountain Rd Newington, CT 06111
Lubricant, penetrating (PMC 9903)	Tri-Flow	Thompson & Formby, Inc. 10136 Magnolia Dr. Olive Branch, MS 38654
Lubricant, sealing ring (PWA 36500)	Ultrachem Assembly Fluid No. 1	Ultrachem Inc Box 2053 1400 N. Walnut St Wilmington, DE 19899
Lacquer, red	Growco (11105)	-
Marker	Felt Wick Pen	Speedry Products Inc Richmond Hill, NY 11418
Marker	Brushpen No. 57	Tex-Rite Products Co Detroit, MI 48232
Marker	Cado	Cushman & Denison Mfg Co Inc New York, NY 10001
Marker	Marks-A-Lot	Carter’s Ink Co 275-T Wyman Street Waltham, MA 02154
Marker	Skilcraft (broad, fine or audiovisual-type tip)	Skil-Craft Corp 325 W. Huron St Chicago, IL 60610

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Maskant, chemical milling (PMC 1801) (PMC 1734)	Turcoform Maskant 531 or M C 25 Maskant	Turco Products Inc. Div. of Elf Atochem 7300 Bolsa Ave. Westminster, CA 92684 Clayton Chem. Co. 2100 Dempster Evanston, IL 60204
Maskant, plasma spray (PMC 1415)	Metco Spray Mask, 15399	Metco, Inc. 1101 Prospect Ave Westbury, L.I. NY 11590
Maskant, strippable coating (PMC 1835)	Turco 5580-G	Turco Products Inc. Div. of Elf Atochem 7300 Bolsa Ave. Westminster, CA 92684
Methyl ethyl ketone	ASTM-D-740	-
Molybdenum disulfide powder (PMC 9523)	MIL-M-7866 or Molykote Z	-
Nickel powder (PWA 6020)	Inco 122	International Nickel Co. Inc. 1 NY Plaza New York, NY 10004
Nitric acid (PMC 1000)	O-N-350	-
Nitrogen, Liquid	PMC 2214	Linde Nitrogen
Nomex yarn - gray	SPES P/N 156416-0008	Simmonds Precision Norwich - Oxford Rd. Norwich, NY 13815
Oil, corrosion preventive	AMS 3065 or MIL-C-15074	-
Oil corrosion preventive	MIL-C-8188	-
Oil, gage lubricant (PMC 9534)	Marvel Mystery Oil	Marvel Oil Co., Inc. 331-337 N. Main St. Port Chester, NY 10573
Oil, lubricating, gas turbine, aircraft (PWA 521, Type I) or (PWA 521, Type II)	MIL-L-7808J or later revision or MIL-L-23699C or later revision	-
Oil, lubricating (PMC 9852)	MIL-L-6081 Grade 1010	-
Oil, lubricating (PMC 9855)	MIL-L-6082 Grade 1065	-
Oil, lubricating, light	MIL-C-16173 Grade 3 Valvoline, Tectyl 894	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Oil, mineral seal (PMC 9002)	Mentor No. 28	Exxon Co USA P.O. Box 2180 Houston, TX 77001
	or 300 Oil 5	Texaco Inc 2000 Westchester Ave White Plains, NY 10650
	or Shell Pella	Shell Oil Co P.O. Box 2463 1 Shell Plaza Houston, TX 77001
	or Sunicut 102	Sun Oil Co of Pennsylvania 1608 Walnut St Philadelphia, PA 19103
Oil, penetrating	VV-P-216	-
Oil, slushing, corrosion preventive, moisture displacing(PMC 9117)	X59-58	Reilly-Whiteman Inc Washington & Righter Sts Conshohocken, PA 19428
	or Ferrocote 362K-2	Quaker Chem Products Corp Lime, Elm & Sandy Sts Coshohocken, PA 19428
	or No. 4042	Pakoil Co 7 N Drexel Ave Havertown, PA 19083
Packing material	-	-
Pad, deep etch	7265-1-D	Electromark Corp 4445 Industrial Pkwy Willoughby, OH 44094
	or 50150FD-SC	Monode Inc 13409 St Clair Ave Cleveland, OH 44110
Pad, electrolyte	4397-1	Electromark Corp 4445 Industrial Pkwy Willoughby, OH 44094
	or 50150SC	Monode Inc 13409 St Clair Ave Cleveland, OH 44110 or Lectroetch Co 14925 Elderwood Ave E. Cleveland, OH 44112

Table 1. Consumable Materials (continued)

Nomenclatureq	Specification/Vendor Part Number	Vendor Address
Paint, Aluminum (PWA 830-S)	SermeTel W or SermeTel 962 or ALSEAL 518 or Ceral 114 or Ceracote 484 or	Sermatech Intl. 155 S Limerick Rd Limerick, PA 19468 Coatings for Industry, Incorporated Souderton, PA 18964 Morant GmbH Bahnhofstr. 110, 8217 Grassau, Germany CFM-GmbH Am Industriepark 3, 84453 Muhldorf, Germany
Paint, finish, high temperature (PWA 499-2)	SermeTel 406	SermeTel Inc 155 S Limerick Rd Limerick, PA 19468
Paper, abrasive	Handi-Mart 30-5160-120-100 30-5160-240-100 30-5160-320-100 30-5160-400-100 30-5160-600-100	Buehler Ltd 41 Waukegan Rd Lake Bluff, IL 60044
Paper, blue carbon	-	-
Paper filler	-	-
Paper, kraft 50 pound (PMC 4128)	Medium duty kraft	St Regis Paper Co 130 E. 42nd St New York, NY 10017
Paper, lapping	400 grit	-
Patches (Barrier material)	2.75 by 5.50 inches	P & W 400 Main Street E.Hartford, CT 06108
Pen, Marking	(PMC 4092-2)	-
Pencil (see crayon)		
Penetrant, Aerokroil	NSN 9150-00-800-7997	-
Penetrant, dye	Spotcheck SKL-HF or Dy-Chek Penetrant or Penetrant P-300	Magnaflux Corp 7300 W. Lawrence Ave Chicago, IL 60656 Purex Corp Turco Products Inc Div 61 Green St P.O. Box 602 Woodbridge, NJ 07095 Uresco Inc 12412 S. Benedict Ave Downey, CA 90242

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Petrolatum, white (PMC 9609)	VV-P-236	-
Plate, flat glass	12 inches square (minimum) × 1/4 inch thick	-
Potassium Hydroxide (PMC 1606)	O-P-566	-
Powder, flame spray nickel/graphite (75/25) (PWA 1352-1)	Metco 307-NS (to PWA 1352-1)	Metco Inc 1101 Prospect Ave Westbury, L.I. NY 11590 or Powder Alloy Corp 823 Maplecrest Dr Troy OH 45373 or Sherritt Gorden Mines Ltd Fort Saskatchewan Alberta, Canada or Alloys Inc 1901 Ellis School Rd Baytown, TX 77521
Powder, flame spray nickel/graphite (85/15) (PWA 1352-2)	Metco 308-NS (to PWA 1352-2)	Metco Inc 1101 Prospect Ave Westbury, L.I. NY 11590 or Powder Alloy Corp 823 Maplecrest Dr Troy OH 45373 or Sherritt Gorden Mines Ltd Fort Saskatchewan Alberta, Canada or Alloys Inc 1901 Ellis School Rd Baytown, TX 77521

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1301) (AMS 7879)	UCAR 202 (to AMS 7879/PWA 1301)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Thermotec 18910 (to AMS 7879/PWA 1301)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or Vertx VPC-01 (to AMS 7879/PWA 1301)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or Haystellite 967F (to AMS 7879/PWA 1301)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or Type SD-251 or SD-255 or SX-182 (to AMS 7879/PWA 1301)	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848
	or Metco 71VF-NS or Metco 71VF-NS-1 (to AMS 7879/PWA 1301)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or AI-1001 (to AMS 7879/PWA 1301)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1301) (AMS 7879) (continued)	Plasmalloy 702-E (to AMS 7879/PWA 1301)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Amdry 301 (to AMS 7879/PWA 1301)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or MOD KS 12 (to AMS 7879/PWA 1301)	Kennametal, Inc P.O. Box 231 981 South St Latrobe, PA 15650
	or Metec (to AMS 7879/PWA 1301)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
	or PAC 1226 (to AMS 7879/PWA 1301)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
Powder, plasma spray (PWA 1302)	Plasmalloy 702-M (to PWA 1302)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Compound SD 252 (to PWA 1302)	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848
	or UCAR 201 (to PWA 1302)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Metco 71-NS (to PWA 1302)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1302) (continued)	Haystellite 967 (to PWA 1302)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or AI-1002 (to PWA 1302)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Vertx VPC-02 (to PWA 1302)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or PAC 125 (to PWA 1302)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
	or Amdry 302 (to PWA 1302)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or Metec 2020C (to PWA 1302)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
Powder, plasma spray (AMS 7875) (PWA 1305)	Haynes Alloy 730F (to AMS 7875/PWA 1305)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or Metco 81VF-NS (to AMS 7875/PWA 1305)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Amdry 305 or 305A (to AMS 7875/PWA 1305)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or AI-1005 (to AMS 7875/PWA 1305)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (AMS 7875) (PWA 1305) (continued)	Plasmalloy 915-E (to AMS 7875/PWA 1305)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or UCAR 204 (to AMS 7875/PWA 1305)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Vertx VPC-05 (to AMS 7875/PWA 1305)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or Thermotec 18973 (to AMS 7875/PWA 1305)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or Metec 2080 VF (to AMS 7875/PWA 1305)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
Powder, plasma spray (PWA 1307)	Plasmalloy 915 (to PWA 1307)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Metec 2080C (to PWA 1307)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
	or Metco 81-NS (to PWA 1307)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Amdry 307 or 307A (to PWA 1307)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1307) (continued)	AI-1007 (to PWA 1307)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Cabot (to PWA 1307)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or UCAR 203 (to PWA 1307)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Vertx VPC-07 (to PWA 1307)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or Thermotec 18970 (to PWA 1307)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or PAC 130 (to PWA 1307)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
	or Compound SX-172 (to PWA 1307)	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848
Powder, plasma spray (PWA 1310)	Plasmalloy 331-FP (to PWA 1310)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Metco 105-NS-1 (to PWA 1310)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1310) (continued)	Bendix No. 400 (to PWA 1310)	The Bendix Corp Abrasives Div Westfield Facility 100 Union St Westfield, MA 01085
	or UCAR 401 (to PWA 1310)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or AI-1010 (to PWA 1310)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Thermotec 18920 (to PWA 1310)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or A-99 (to PWA 1310)	Muscle Shoals Minerals Co P.O. Box 518 Tuscumbia, AL 35660
Powder, plasma spray (PWA 1312)	Plasmalloy 327-M (to PWA 1312)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Metco 201B-NS (to PWA 1312)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or AI-1012 (to PWA 1312)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or PAC 801B (to PWA 1312)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
	or Thermotec 18922 (to PWA 1312)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1313)	Plasmalloy 111-M (to PWA 1313)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Metco 63-NS (to PWA 1313)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Sylvania Grade 450, Compound SD 151 (to PWA 1313)	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848
	or Alloys 1013 (to PWA 1313)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Amdry 113 or 313 (to PWA 1313)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or Thermotec 18851 (to PWA 1313)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or PAC 118-NS (to PWA 1313)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
	or Metec 3010C (to PWA 1313)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1314)	Amdry 314 (to PWA 1314)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
Powder, plasma spray (PWA 1315)	Metco 43C-NS (to PWA 1315)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or UCAR 607 (to PWA 1315)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Haynes Alloy 2315 (to PWA 1315)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or Plasmalloy 207-M (to PWA 1315)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or Amdry 315 (to PWA 1315)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or AI-1015 or AI-1015-2 (to PWA 1315)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Thermotec 18930 (to PWA 1315)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or Vertx VPC-15 (to PWA 1315)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or PAC 98C-1 (to PWA 1315)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1316)	Stellite 31F (to PWA 1316)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or UCAR 608 (to PWA 1316)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Amdry 316 (to PWA 1316)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or AI-1016 (to PWA 1316)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Metco 45VF-NS (to PWA 1316)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Vertx VPC-16 (to PWA 1316)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or PAC 90-VF (to PWA 1316)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
Powder, plasma spray (PWA 1317)	Plasmalloy 207-F (to PWA 1317)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or UCAR 602 (to PWA 1317)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Ancor 80Ni-20Cr (to PWA 1317)	Hoeganaes Sponge Iron Corp River Rd & Taylor’s Lane Riverton, NJ 08077
	or	

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1317) (continued)	Amdry 317 (to PWA 1317)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or Metco 43F-NS (to PWA 1317)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Haynes Alloy 2315 (to PWA 1317)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or Vertx VPC-17 (to PWA 1317)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or Thermotec 18923 (to PWA 1317)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or Metec 4050M (to PWA 1317)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
	or GTE Sylvania (to PWA 1317)	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848
	or AI-1017 (to PWA 1317)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or PAC 85F (to PWA 1317)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1318)	Stellite 31 (to PWA 1318)	Cabot Corp Cabot Wrought Products Div 1020 W. Park Ave Kokomo, IN 46901
	or UCAR 609 (to PWA 1318)	Union Carbide Corp Coatings Service P.O. Box 24184 1245 Main St Indianapolis, IN 46224
	or Amdry 318 (to PWA 1318)	Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
	or Metco 45C-NS (to PWA 1318)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Vertx VPC-18 (to PWA 1318)	Special Metals Corp Udimet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104
	or AI-1018 (to PWA 1318)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Thermotec 18981 (to PWA 1318)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
	or Metec 4060 (to PWA 1318)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1320)	Metco 54-NS (to PWA 1320)	Metco, Inc 1101 Prospect Ave Westbury L.I., NY 11590
	or Plasmalloy 100-N (to PWA 1320)	Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702
	or AI-1020 (to PWA 1320)	Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521
	or Thermotec 18909 (to PWA 1320)	Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
Powder, plasma spray (PWA 1321)	Metco 404-NS (to PWA 1321)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
Powder, plasma spray (PWA 1322)	Metco 439-NS (to PWA 1322)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
Powder, plasma spray (PWA 1333)	Metco 210-NS (to PWA 1333)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
	or Norton 9897 (to PWA 1333)	Norton Co 1 New Bond St Worcester, MA 01606
	or MZ80 (to PWA 1333)	Muscle Shoals Minerals Co P.O. Box 518 Tuscumbia, AL 35660
	or Zircoa 15313 (to PWA 1333)	Corning Glass Works 31501 Solon Rd Solon, OH 44139
	or Metec 1150M (to PWA 1333)	Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1335)	Cerak-1064 (to PWA 1335) or Metco 52C-NS (to PWA 1335) or AI-1035 (to PWA 1335) or PAC 901 (to PWA 1335)	Cerac, Inc P.O. Box 1178 Milwaukee, WI 53201 Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590 Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521 Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373
Powder, plasma spray (PWA 1337)	Metco 450-NS (to PWA 1337) or Amdry 956 (to PWA 1337)	Metco, Inc 1101 Prospect Ave Westbury L.I., NY 11590 Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084
Powder, plasma spray (PWA 1338)	Sylvania Compound SA 103 (to PWA 1338) or Amdry 338 (to PWA 1338) or Plasmalloy 111F (to PWA 1338) or Thermotec 18983 (to PWA 1338) or	GTE Sylvania Precision Matls Group Chem & Metallurgical Div P.O. Box 70 Towanda, PA 18848 Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084 Geotel, Inc Plasmadyne Div 3839 S. Main St Santa Ana, CA 92702 Eutectic Corp 40 - 40 172nd St Flushing, NY 11358

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1338) (continued)	PAC 118FNS (to PWA 1338) or Metec 3010 VF (to PWA 1338)	Powder Alloy Corp 823 Maplecrest Dr Troy, OH 45373 Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
Powder, plasma spray (PWA 1340)	Metco 460 (to PWA 1340) or AI-1040 (to PWA 1340) or (to PWA 1340) or may be made up as a blend, using 95% (by weight) PWA 1323: Vertx VPC-23 (to PWA 1323) or DSF (to PWA 1323) or (to PWA 1323) and 5% (by weight) PWA 1327 Alcoa 101 (to PWA 1327) or AI-1027 (to PWA 1327)	Metco Inc 1101 Prospect Ave Westbury, L.I., NY 11590 Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521 or Union Carbide Corp Coatings Service P.O. Box 24184 Indianapolis, IN 46224 Special Metals Corp Uditmet Powder Div 2310 S. Industrial Hwy Ann Arbor, MI 48104 Sherritt Gordon Mines Ltd Fort Saskatchewan Alberta, Canada Alloy Metals Inc 501-T Executive Dr Troy, MI 48084 Aluminum Corp of America 1226 Alcoa Bldg. Pittsburg, PA 15219 Alloys Inc 1901 Ellis School Rd Baytown, TX 77520

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, plasma spray (PWA 1341)	Metco 421-NS-1 (to PWA 1341)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590
Powder, plasma spray (PWA 1346)	Metco 303-NS (to PWA 1346) or General Plasma Associates (to PWA 1346) or AI-1046 (to PWA 1346) or Thermotec 18964 (to PWA 1346)	Metco, Inc 1101 Prospect Ave Westbury, L.I., NY 11590 General Plasma Associates 12 Thompson Rd East Windsor, CT 06088 Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521 Eutectic Corp 40 - 40 172nd St Flushing, NY 11358
Powder, plasma spray (PWA 1347)	Metco 443-NS (to PWA 1347) or Amdry 960 (to PWA 1347) or AI-1047 (to PWA 1347) or Metec 4020C (to PWA 1347)	Metco, Inc 1101 Prospect Ave Westbury L.I., NY 11590 Alloy Metals, Inc 501-T Executive Dr Troy, MI 48084 Alloys, Inc 1901 Ellis School Rd Baytown, TX 77521 Metec, Inc 385 Prospect Ave Suite 2000 Hackensack, NJ 07601
Powder, plasma spray (PWA 1349)	Metco 601-NS (to PWA 1349)	Metco, Inc 1101 Prospect Ave Westbury L.I., NY 11590
Powder, plasma spray (PWA 1369)	Metco 57-NS (to PWA 1369)	Metco, Inc 1101 Prospect Ave Westbury L.I., NY 11590

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Powder, talcum	-	-
Primer, adhesive/sealant (PWA 556)	DC 1200	Dow Corning Corporation Midland, MI 48640
Primer, gray	-	SCM Corporation Glidden-Durkee Div 900 Union Commerce Blvd Cleveland, OH 44114 or Pratt & Lambert, Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 14240
Primer	Dow Corning 1204	Dow Corning Corporation Midland, MI 48640
Primer, epoxy (PWA 568)	Primer Base, 519 X 303 Curing Solution 910 - 357 Solvent, 020 X 324	Desoto, Inc Garland, TX 75040
Primer for aluminum before Teflon coating (PMC 1716)	No. 850 - 202	DuPont Co 308 E. Lancaster Ave Wynnewood, PA 19036
Primer for steel or titanium before Teflon coating (PMC 1715)	No. 850 - 201	DuPont Co 308 E. Lancaster Ave Wynnewood, PA 19036
Primer, quick	MIL-S-22473, Grade T or Locquic Primer T	- Loctite Corp 705 N. Mountain Rd Newington, CT 06111
Primer, sealant (PWA 543)	SermeTel 331	SermeTel, Inc 155 S. Limerick Rd Limerick, PA 19468

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Primer, zinc chromate (AMS 3110)	TT-P-1757	-
Pumice (PMC 3001)	Grade FFF	MacDermid, Inc. 50 Brookside Rd. P.O. Box 671 Waterbury, CT 06708-1402
Remover, paint, organic solvent-type	TT-R-251	-
Remover, RTV silicone rubber compound	Cee Bee C105HF or Cee Bee C105NC or Turco 6045	McGean-Rohco, Inc. 9520 E. Ceebee Dr. P.O. Box 7000 Downey, CA 90241-0016 Turco Products, Inc. 7300 Bolsa Ave. Westminster, CA 92684-3600
Resin, fluorocarbon (PWA 36038)	Dupont 954-101	Dupont Co. 1007 Market St. Wilmington, DE 19898
Resin, polyurethane, clear finish (PWA 567)	QS 2040 or Q-Thane MC-40	Prime Polymers, Inc. 638 Summer St. Lynn, MA 01905 K.J. Quinn & Co., Inc. 195 Canal Street Malden, MA 02148
Retarder (PMC 1647)	Cellosolve Acetate	Union Carbide Corp. Old Ridgebury Rd. Danbury, CT 06817
Rod, rubberized abrasive	CRATEX 86XF or as specified	Cratex Mfg. Co., Inc. 328 Encinitas Blvd. Suite 200 Encinitas, CA 92024

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Sealant/adhesive, silicone rubber (PWA 36057-1)	RTV 116	General Electric Silicone Products Dept. Waterford, NY 12188
Sealant, ceramic - metallic (PWA 553)	Tipersul	United Technologies Corp. Pratt & Whitney Government Products Div P.O. Box 109600 W. Palm Beach, FL 33410-9600
	and PWA 552 high temperature cement, two component type, SermaBond 481 Part I (compound) and Part II (hardener)	Sermatech Int’l, Inc. Materials Division 155 S. Limerick Rd Limerick, PA 19468
Sealant, silicone rubber (PWA 407)	Visilox V-622	Loctite VSI, Inc. Newington, CT 06111
Sealant (PWA 36029)	Catalog No. 732	Dow Corning Corp. Englewood Cliffs, NJ 07632
Sheet stock	AMS 5608 cobalt alloy (Sheet 0.034 to 0.043 inch thick)	-
Shot, steel, cast Size 70	MIL-S-13165/ SAE 70	-
Shot, steel, cast Size 110	MIL-S-13165/ SAE 110	-
Shot, steel, cast Size 170	MIL-S-13165/ SAE 170	-
Silver nitrate (PMC 1767)	-	Fisher Scientific Co. 52 Fadem Rd Springfield, NJ 07081
Slurry, aluminum silicon, touch-up (PWA 596)	Sermaloy J	Sermatech Int’l, Inc. Materials Division 155 S. Limerick Rd Limerick, PA 19468

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Slurry, cobalt aluminum touch-up (PWA 545)	P&WA PN SR741613	United Technologies Pratt & Whitney Government Products Div P.O. Box 2691 W. Palm Beach, FL 33402
Slurry, green ceramic (PWA 599)	Solaramic S5-8A	International Harvester Co Solar Div 2200 Pacific Hwy San Diego, CA 92112
Soap solution	Fleetline 205	Oakite Products Inc 50 Valley Rd Berkely Hts., NJ 07922
Sodium bicarbonate	-	-
Sodium gluconate	-	-
Sodium hydroxide (PMC 1601)	O-S-598	-
Sodium lauryl sulfate (SPMC 87)	-	Mckesson Chemical Co 4351 Director Dr San Antonio, TX 78219 or Accron Chemical Co 3251 N. Pan Am Expy San Antonio, TX 78219
Solvent, degreasing	O-T-236 or MIL-T-81533	-
Solution, cleaning	Pasa-Jell 107	SEMCO Division of Products Research and Chemical Corp 5454 San Fernando Rd Glendale, CA 91203
Solvent, petroleum	P-D-680, Type II or Type III	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Solvent reducer for epoxy primer or enamel (PWA 36050)	020 to 324	Desoto, Inc. Garland, TX 75040
Solution, replicating	No. 451	Ladd Rsch Industries, Inc. P.O. Box 1005 Burlington, VT 05402
Stencil	9001 or D-I paper or L paper	Electromark Corp 445 Industrial Pky Willoughby, OH 44094 Monode Inc. 13409 St Clair Ave. Cleveland, OH 44110 Lectroetch Co. 14925 Elderwood Ave E. Cleveland, OH 44112
Stick, abrasive silicon carbide	Norton 37C 400H	Norton Co. 1 New Bond St. Worcester, MA 01606
Stick, abrasive silicon carbide (diamond wheel dressing)	Norton 37C 400HV or Carborundum No. 349	Norton Co. 1 New Bond St. Worcester, MA 01606 The Carborundum Co. P.O. Box 337 Buffalo Ave Niagara Falls, NY 14302
Stone, abrasive	-	Norton Co. Coated Abrasive Division 10th Ave. & 27th St. P.O. Box 808 Troy, NY 12181
Stone, rubberized abrasive, extra fine grit	Cratex No. 3802 XF	Cratex Mfg. Co., Inc. 328 Encinitas Blvd. Suite 200 Encinitas, CA 92024

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Stop-Off	Metco Anti-Bond	Metco Inc 1101 Prospect Ave Westbury, L.I., NY 11590
Stop-Off (PMC 1642)	Nicrobraz Green Stop-Off Nicrobraz White Stop-Off or Pink Stop-Off	Wall Colmonoy Corp 19345 John R. St Detroit, MI 48203 Vac-Hyd Corp 15701 Glendale Ave Detroit, MI 48227
Stop-off (PMC 2266)	Stopyt	GTE Products Corp WESGO Div 477 Harbor Blvd Belmont, CA 94002
Stripping paint (SPMC 68)	Cee-Bee A227D	McGean Rohco Inc Rohco Div 9520 E Cee Bee Drive Downey, CA 90241
Sulfamic acid (PMC 1550)	-	Richardson Co , Allied-Kelite Products Division 81 Industrial Rd Berkeley Heights, NJ 07922 or Chempure Corp 1011 Davis Rd Elgin, IL 60120
Sulfuric acid (PMC 1003)	O-S-809	-
Tape, doublefaced	No. 942	Nashua Corp Industrial Tape Division 44 Franklin St Nashua, NH 03061
Tape, glass cloth (PWA 36400)	MIL-I-19166 No. 69 Fiberglass	- 3M Co 3M Center St Paul, MN 55144

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Tape, heat reflective (PMC 4235)	363 or 2925-7 or 390	3M Co 3M Center St Paul, MN 55144 Oak Materials Group, Inc Fluorglas Div Hoosick Falls, NY 12090 Lamart Corp 16 Richmond St Clifton, NJ 07015
Tape, heat resistant	Joclin 404	3M Co Adhesives, Coatings, and Sealers Div St Paul, MN 55101
Tape, high temperature, glass cloth (PMC 4273)	No. 361 Glass cloth tape	3M Co Adhesives, Coatings, and Sealers Div St Paul, MN 55101
Tape, KAPTON	Airkap T.T.	Airtech International 2542 E. Delamo Blvd. Carson, CA 90749
Tape, knitted metal mesh	PN 05-0720-0432-02	Shielding Technology, Inc P.O. Box 236 Piscataway, NJ 08854
Tape, masking (cloth backing) (PMC 4001)	F.O.S. 57-2 red or Tuck 90-W red or 222 or TB-30-113	Seamless Rubber Co 253 Hallock Ave New Haven, CT 06503 Tuck Industries, Inc Lefevre Lane New Rochelle, NY 10801 Kendall Corp Polyken Div 20 Walnut St Wellesley Hills, MA 02181

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Tape, masking, (crepe paper backing) (PMC 4000)	441 tape	Norton Co Coated Abrasives and Tape Div P.O. Box 54 Troy, NY 12181
	or Tuck 138	Tuck Industries Inc Leferre Lane New Rochelle, NY 10801
	or 2505	3M Co Adhesive Coatings and Sealers Div St Paul, MN 55101
	or PG-4	Armak Industrial Products 1 Altman Drive Rutherford, NJ 07070
	or Permacel 786 tape	Johnson & Johnson Inc Permacel Div P.O. Box 671 New Brunswick, NJ 08903
Tape, masking, general purpose	Scotch No. 232	3M Co Adhesives, Coatings, and Sealers Div St Paul, MN 55101
	or Tuck No. 122	Tuck Industries, Inc Lefevre Lane New Rochelle, NY 10801
	or Permacel No. 701	Johnson & Johnson, Inc Permacel Div P.O. Box 671 New Brunswick, NJ 08903

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Tape, masking, high temperature (PMC 4009)	Scotch High Temp 213	3M Co Adhesives, Coatings, and Sealers Div St Paul, MN 55101
	or Hi-Temp 134	Tuck Industries, Inc Lefevre Lane New Rochelle, NY 10801
	or Permacel 703	Johnson & Johnson, Inc Permacel Div P.O. Box 671 New Brunswick, NJ 08903
	or PG-8	Armak Co 300 S. Wacker Dr Chicago, Il 60606
Tape, masking, metallic (lead foil) (PMC 4138)	Scotch No. 421	3M Co Adhesive Coatings and Sealers Div 3M Center St Paul, MN 55101
Tape, masking, plastic	Scotch No 484	3M Co Adhesives Coatings, and Sealers Div 3M Center St Paul MN 55144
	or Prata PV-165B	J. B. Prata, Ltd 1486 Westminster St Providence, RI 02909
Tape, masking, plastic (tapered) (PMC 4139)	Microtape	Michigan Chrome and Chem Co 8615 Grinnell Ave Detroit, MI 48213

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Tape, masking, zinc (PMC 5008)	Commercial zinc tape	The Bristol Brass Corp Noble and Westbrook Mfg Co Div 20 Westbrook St E. Hartford, CT 06108
Tape, metal foil	Scotch No. 428B	3M Co Adhesive Coatings and Sealers Div St Paul, MN 55101
Tape, pressure sensitive	P 24048	-
Tape, replicating	No. 453	Ladd Rsch Industries Inc P.O. Box 901 Burlinton, VT 05401
Tape, stainless steel	10 mil. shim stock	Eastern Industries 114 John Downey Dr. New Britain, CT 06051
Tape, transparent plastic	No. 681	3M Co Adhesives, Coatings, and Sealers Div 3M Center St Paul, MN 55144
Tetrachloroethylene (Perchlorethylene)	O-T-236	-
Thermocouples	A4-2x28 inch with style 9 termination, 28 gage wire with flattened bead.	Nanmac Mayhew St. Framingham Centre, MA 01701
Thinner, alcohol Ester	AMS 3170	-
Thinner, paint (enamel)	KT 69	Pratt & Lambert Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 14240

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Thinner, fast dry (PMC 9715)	KT 46 thinner	Pratt & Lambert Inc l75 Tonawanda St P.O. Box 22 Buffalo, NY 14240
Thinner, slow dry (PMC 9714)	Reducer No.V-144	Pratt & Lambert Inc l75 Tonawanda St P.O. Box 22 Buffalo, NY 14240
Thiourea (SPMC 86)	-	-
Tissue, wiping (PMC 4181)	2500 Neutracleaning wiping tissue	Electromark Corp 4445 Industrial Pky Willoughby, OH 44094 or Lectroetch Co 14925 Elderwood Ave E. Cleveland, OH 44112
Tissue, wiping (PMC 4169	Kimwipes 900S	Kimberly - Clark 128 N. Lake St Neenah, WI 54956
	or Micro-wipes No. 05310	Scott Paper Co Scott Plaza 2 Philadelphia, PA 19113
Toluene (PMC 9072)	AM 3180 TT-T-548	-
Trichloroethane inhibited -1,1,1	O-T-620	-
(PMC 9056)	MIL-T-81533	-
Trichlorotrifluoroethane	MIL-C-81302, Type II	-
Tungsten carbide (sintered cutter)	Kennametal K68 or Valenite VC 29 or Carboloy Grade 895 or Firth Sterling grade HTA	-

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Varnish, synthetic resin	AMS 3132 MIL-R-3043	-
Varnish, graphite premixed	PN 0548	Pratt & Lambert Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 1424
Water, distilled or deionized	PMC 1737	-
Wax, hydrocarbon, noncrystalline (PWA 36018)	Flexowax C Light	Glyco Chem Inc 417 Fifth Ave New York, NY 10016
Wax, masking (PMC 9551)	Micro Wax C562 or Cerita 361B masking wax or 64-0504	Mi Chrome & Chem Co 8615 Grinnell Ave Detroit, MI 48213 M. Argueso & Co Inc 441 Waverly Ave Mamaroneck, NY 10543 F B Ross Co 6 - 10 Ash St Jersey City, NJ 07304
Wax, paraffin refined	VV-W-95 or Exxon 125-127 AMP	 Exxon Co USA P.O. Box 2180 Houston, TX 77001
Wheel, hemp	-	-
Wheel, aluminum oxide	32A60-I8 VBE	Norton Co 1 New Bond St Worcester, MA 01606
Wheel, grinding diamond, No. 220 grit size, high (100) concentration	Resinoid L or N	Norton Co 1 New Bond St Worcester, MA 01606
Wheel, abrasive	2579-2CH	Cratex Mfg. Co., Inc. 328 Encinitas Blvd. Suite 200 Encinitas, CA 92024

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Wheel, diamond	Resinoid L or N 100 grit size high (100) concentration (SD 280-N100B 56 1/8)	Norton Co 1 New Bond St Worcester, MA 01606
Wheel, silicon carbide	X 80-J	Jowitt & Rodgers Co 9400 State Rd Philadelphia, PA 19114
Wheel, silicon carbide	37C80-I8V	Norton Co 1 New Bond St Worcester, MA 01606
Wire, aluminum	AMS 4180 (1100-H18) MIL-W-6712, Type II aluminum	-
Wire, flame spray (PWA 1334)	Metco 405-NS 78 Ni-22A1	Metco Inc 1101 Prospect Ave Westbury L.I. NY 11590
Wire, hardface welding (PWA 795)	MERL 72	Cabot Corporation Wear Technology Div Kokomo, IN 64901 or Polymet Corporation Cincinnati, OH 45246 or Special Metals Corporation New Hartford, NY 13413 or United States Welding Corporation 20700 Dearborn St Chatsworth, CA 91311
Wire, welding, cobalt (PWA 694)	No. 64	Coast Metals Inc 201 Redneck Ave P.O. Box 7 Little Ferry, NJ 07643

Table 1. Consumable Materials (continued)

Nomenclature	Specification/Vendor Part Number	Vendor Address
Wire, welding	AMS 4190 (4043, QQ-R-566 CL4043) AMS 4941 AMS 4951 AMS 4955 AMS 4956 AMS 5679 (Inconel 62) AMS 5680 (30340, MIL-R-5031 CL5) AMS 5683 (MIL-R-5031 CL8) AMS 5687 (600, QQ-W-390) AMS 5689 (30321, QQ-W-423 Comp 321) AMS 5789 (Stellite 31) AMS 5796 (Cobalt, L-605, MIL-R-5031 Comp 13) AMS 5801 (Haynes 188) AMS 5828 (Waspaloy) AMS 5829 (Nimonic 90) AMS 5837 (Inconel 625)	-
	No. 64 (Inconnel 718, AMS 5832)	Coast Metals Inc 201 Redneck Ave P.O. Box 7 Little Ferry, NJ 07643
	PWA 795 (Cobalt base)	United Technologies Pratt & Whitney Government Engines & Space Propulsion P.O. Box 109600 W. Palm Beach, FL 33410-9600
Xylene (PMC 9064)		Fisher Scientific Co 52 Fadem Rd Springfield, NJ 07081
Zinc chromate primer	TT-P-1757 AMS 3110	Pratt & Lambert Inc 75 Tonawanda St P.O. Box 22 Buffalo, NY 1424

WORK PACKAGE

MASTER LIST OF APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

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1	28	3 - 5	19	6 - 8	28
2	0				

1. INTRODUCTION.

a. This work package lists all applicable time compliance technical orders (TCTOs) referenced throughout this manual set.

b. TCTOs are also listed in all other technical orders of this manual set and in work packages and subordinate work packages to which they apply.

T.O. No.	Date	Level	Title (ECP No.)
2J-F100-847	15 May 92	O/I	Retrofit of RCVV Actuator Cylinder PN 4071524 Incorporating a Minus 34 Degree Stop, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA289)
2J-F100-885	31 Oct 95	I	Modification of PWA 57649 Adapter Set and Reidentification to PWA 57806, F100-PW-100/-200/-220/-220E/-229 Engines, F-15/F-16 Aircraft (EC 93QC203)
2J-F100-886	31 Oct 95	I	Reoperation of PWA 57650 Adapter Set and Reidentification to PWA 57807, F100-PW-100/-200/-220/-220E/-229 Engines, F-15/F-16 Aircraft (EC 93NC328)
2J-F100(II)-603	28 Feb 92	O/I	Retrofit of Combustion Chamber No. 2 ID Liner Segments to Improve Combustion Exit Temperature Profile, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA280)
2J-F100(IV)-544	30 Aug 91	O/I	Installation of Redesigned Augmentor Combustion Chamber Assembly, F100-PW-229 Augmentor Module, F100-PW-229 Engines (ECP 89QA758)

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229-528	15 Apr 93	O/I	Installation of Redesigned Flexible Hose for RCVV Extend/Retract Tubes, F100-PW-229 Engine, F-15 Aircraft (ECP 92QA292)
2J-F100229-533	30 Jul 93	O/I	Remove and Replace Various External Stainless Steel Tubes/Manifold Assemblies with Non-Metallic (Flexible) Hose/Nickel Base Tubes, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 92QA096)
2J-F100229-535	30 Jul 93	O/I	Redesigned PF1 Tube Block Clamp Bracket PN 4074501 to Prevent Chafing, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 92QA068)
2J-F100229-545	15 Sept 94	O/I	Remove and Replace Various External Tubes and Manifolds With Nickel Base and Titanium Base Alloy in Place of Stainless Steel Material, F100-PW-229 Engine, F-15/ F-16 Aircraft (ECP 92QA097)
2J-F100229-546	30 Sept 95	O/I	Modification of Retainer Ball Lock Pin Handle PWA 57614, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 93QC038)
2J-F100229-551	01 Nov 94	O/I	Installation of Increased Clearance CIVV Tube PN 4081545-01 to Maximum Clearance With the RCVV Feedback Cable, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 93QA175)

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229-552	01 Nov 94	O/I	Installation of New Loop Clamp Bracket Assembly PN 4082284-01 and Attaching Hardware at the FTIT Harness and No. 5 Oil Supply Tube Assembly, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 93QA205)
2J-F100229-553	15 Feb 95	O/I	Modification of PWA 57653 Tool Set, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 94QC004-1)
2J-F100229-554	15 Feb 95	O/I	Modification of PWA 57704 Adapter, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 89QA624-1)
2J-F100229-557	1 Jan 95	O/I	Replacement of Engine Diagnostic Unit (EDU) Cooling Tubes, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 94QA006)
2J-F100229-560	30 Apr 95	O/I	Reoperation of PWA 57742, No. 4 Bearing Front Seal Assembly Leak Check Fixture, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 93QC001AR1)
2J-F100229-562	30 Sept 95	O/I	Retrofit of Generator Cable Connector Clamp PN 4082678-01 and Attaching Hardware, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 94QA072)
2J-F100229-564	30 Nov 95	O/I	Remove and Replace No. 4 Bearing Oil Pressure Transfer Tube and Install Conical Seal, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 91QA245)
2J-F100229-565	15 Feb 96	O/I	Retrofit of Gearbox Oil Supply Tubes and Manifolds For Improved Gearbox Oil Flow, F100-PW-229 Engine, F-16 Aircraft (ECP 94QA075)
2J-F100229-569	30 Nov 95	O/I	Retrofit of New Pt6/Pb Water Trap for 1/4 Inch Tube Durability Improvement, F100-PW-229 Engines, F-16 Aircraft (ECP 93QA010R1)

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229(I)-503	7 May 93	I	Incorporation of Revised Inlet Case Clamping to Eliminate Chafing, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 92QA016)
2J-F100229(I)-505	30 Jul 93	O/I	Remove and Replace PS2 Sense Tubes (PN 4071694-01 and PN 4071695-01) with Non-Metallic (Flexible) Hose/Nickel Base Tubes, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 92QA096)
2J-F100229(I)-508	1 Mar 94	O/I	Install Composite CIVV Bellcrank Bushings, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 92QA291)
2J-F100229(I)-514	30 Nov 95	O/I	Replacement of Compressor Inlet Variable Vane (CIVV) Actuator Rod Clevises PN 4075565 and PN 4075566, F100-PW-229 Engines, F-16 Aircraft (ECP 95QA027)
2J-F100229(II)-509	15 Apr 92	O/I	Retrofit of 4th through 9th Stage Compressor Stator Assembly Featuring Proportionally Scheduled 5th Stage Variable Vanes and Non-variable 6th Stage Vanes, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA096)
2J-F100229(II)-510	30 Aug 93	O/I	Reoperation of Hardware for Proportionally Scheduled 5th Stage Variable Vanes and Non-variable 6th Stage Vanes, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA096)
2J-F100229(II)-514	15 Jun 98	D	Retrofit of PN 4077913 Rear Compressor Exit Stator Assembly Featuring PN 4077422 Compressor Damper, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 89QA728)
2J-F100229(II)-519	31 Dec 93	O/I	Retrofit of Improved 4th and 5th Stage Bushings to Eliminate Back-out, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 92QA105)
2J-F100229(II)-523	30 Nov 93	O/I	Remove and Replace No. 4 Bearing Air Seal Assembly PN 4074849 with New Assembly Featuring Increased Forward Snap Diameter, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA181)
2J-F100229(II)-532	30 Nov 95	O/I	Remove and Replace No. 4 Bearing Oil Pressure Transfer Tube, B-Nut, and Install Conical Seal, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 91QA245C2)

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229(II)-536	30 Jul 95	O/I	Installation of No. 3 Bearing Rear Seal Assembly, PN 4068215 Incorporating No. 3 Bearing Support PN 4068182 or PN 4080875-01 Incorporating No. 3 Bearing Support PN 4080874 and Installation of No. 3 Bearing Air Seal PN 4080811, F100-PW-229 Engines, F-16 Aircraft (ECP 91QA186R2)
2J-F100229(II)-538	15 Mar 96	O/I	Retrofit of No. 2/3 Bearing Crossover Housing Aft Flange Bolts PN ST5001-12 Featuring Increased Strength and Torque, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 92QA295C1)
2J-F100229(II)-548	30 May 97	D	Reoperation of Diffuser Case Assembly OD Rear Flange to Incorporate a New Short Skirt Configuration, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 96QA053)
2J-F100229(II)-550	15 May 98	D	Final Assembly of Core Module Featuring ’97 Enhancement Package, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 96QA053)
2J-F100229(II)-559	15 Oct 98	D	Retrofit of New Right and Left Fuel Supply Tube Assemblies and Attaching Hardware, F100-PW-229 Engines, F-15 Aircraft (ECP 96QA179)
2J-F100229(II)-560	1 May 98	D	Retrofit of New Right and Left Fuel Supply Tube Assemblies and Attaching Hardware, F100-PW-229 Engines, F-16 Aircraft (ECP 96QA179)
2J-F100229(III)-508	1 Mar 94	O/I	Install Improved Durability Fourth Blade Outer Air Seal, F100-PW-229 Engine, F-15/F-16 Aircraft (ECP 91QA300)
2J-F100229(III)-516	15 Feb 95	O/I	Remove and Replace Second Stage Turbine Duct Support and Segment, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 90QA218)
2J-F100229(III)-517	15 Feb 95	D	Installation of Improved Durability 4th Stage Turbine Blade PN 4082504, Disk PN 4082604 and Air Seal PN 4082297, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 93QA253R1C1)

T.O. No.	Date	Level	Title (ECP No.)
2J-F100229(III)-518	15 Feb 95	O/I	Installation of Improved Durability 4th Stage Turbine Blade PN 4082504, Disk PN 4082604 and Air Seal PN 4082297, F100-PW-229 Engines, F-15 Aircraft (ECP 93QA253R1)
2J-F100229(IV)-501	15 May 93	O/I	Incorporation Of Augmentor Combustion Chamber Liner Assembly Cylindrical Section Durability Improvements, F100-PW-229 Engines, F-15/F-16 Aircraft(ECP 91QA082)
2J-F100229(V)-501	01 Jan 95	O/I	Incorporation Of 30 Micron Oil Filter With Full-Flow Bypass Valve, F100-PW-229 Engines, F-15/F-16 Aircraft(ECP 90QA168C1)
2J-F100229(V)-504	15 Sep 94	D	Installation Of Increased Life Power Take Off (PTO) Duplex Bearing P/N 4080062-01, F100-PW-229 Engine, F-15/F-16 Aircraft(ECP 92QA151)
2J-F100229(V)-508	13 Feb 96	O/I	Replacement of Main Oil Pump Adapter, PN ST2000-10, F100-PW-229 Engines, F-16 Aircraft (ECP 95QA315)
2J-F100229(V)-509	13 Feb 96	O/I	Replacement of Main Oil Pump Adapter, PN ST2000-10, F100-PW-229 Engines, F-15 Aircraft (ECP 95QA315)
2J-F100229(V)-510	13 Feb 96	O/I	Replacement of Gearbox Assembly Bolts, PN MS9519-13, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 95QA315)
2J-F100229(VI)-506	15 Mar 95	O/I	Reoperation of PWA 57503 Assembly/ Disassembly Stand for F100-PW-229 High Pressure Turbine, (ECP 90QA009-1)
2J-F100229(VI)-507	27 Feb 95	O/I	Remove and Replace First Turbine Duct and Support Set To Provide Increased Cooling and Higher Margin Material First Duct Segments for F100-PW-229 Engines, F-15/F-16 Aircraft(ECP 94QA197)
2J-F100229(VI)-508	12 May 95	D	Reoperation of F100-PW-229 High Pressure Turbine Container PN 4070548 (ECP 90QA009)
2J-F100229(VI)-515	01 Apr 96	D	Installation of High Pressure Turbine 1-2 Spacer Damper PN 4082885 to Prevent Misinstallation, F100-PW-229 Engines, F-15/F-16 Aircraft (ECP 94QA114)

WORK PACKAGE

INTRODUCTION

GENERAL ENGINE AND SYSTEMS DESCRIPTION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 2

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	0				

1. INTRODUCTION

a. This work package introduces the 005 00 through 019 00 series of work packages for the F100-PW-229 gas turbine engine. The following work packages are included in the series:

WP No.	Title
006 00	Basic Engine Information
007 00	Basic Engine Features
008 00	Inlet/Fan Module - Description
009 00	Core Engine Module - Description
010 00	Fan Drive Turbine Module - Description
011 00	Augmentor Duct and Nozzle Module - Description
012 00	Gearbox Module - Description
013 00	Fuel and Control Systems - Description
014 00	Electrical System - Description
015 00	Oil System - Description
016 00	Compressor Inlet Variable Vane Actuation System, Rear Compressor Variable Vane Actuator System, and Start Bleed System - Description
017 00	Anti-icing System - Description
018 00	Augmentor Nozzle Actuation System - Description
019 00	Open

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

BASIC ENGINE INFORMATION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	21	10	21	12	21
2 - 9	0	11	0	13 - 14	0

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general information about the F100-PW-229 engine.

b. This work package:

- explains engine directional references
- lists external flanges
- identifies engine stations and main bearings

c. It also provides:

- basic engine data and specifications
- shipping information
- locations of engine and module identification plates

2. DIRECTIONAL REFERENCES.
(See Figure 1.)

a. The engine is viewed:

- from the rear (exhaust end)
- with the gearbox on the bottom

b. Directional references (right and left, clockwise and counterclockwise, upper and lower) and clock positions (12 o’clock, 6 o’clock) are applied using this view.

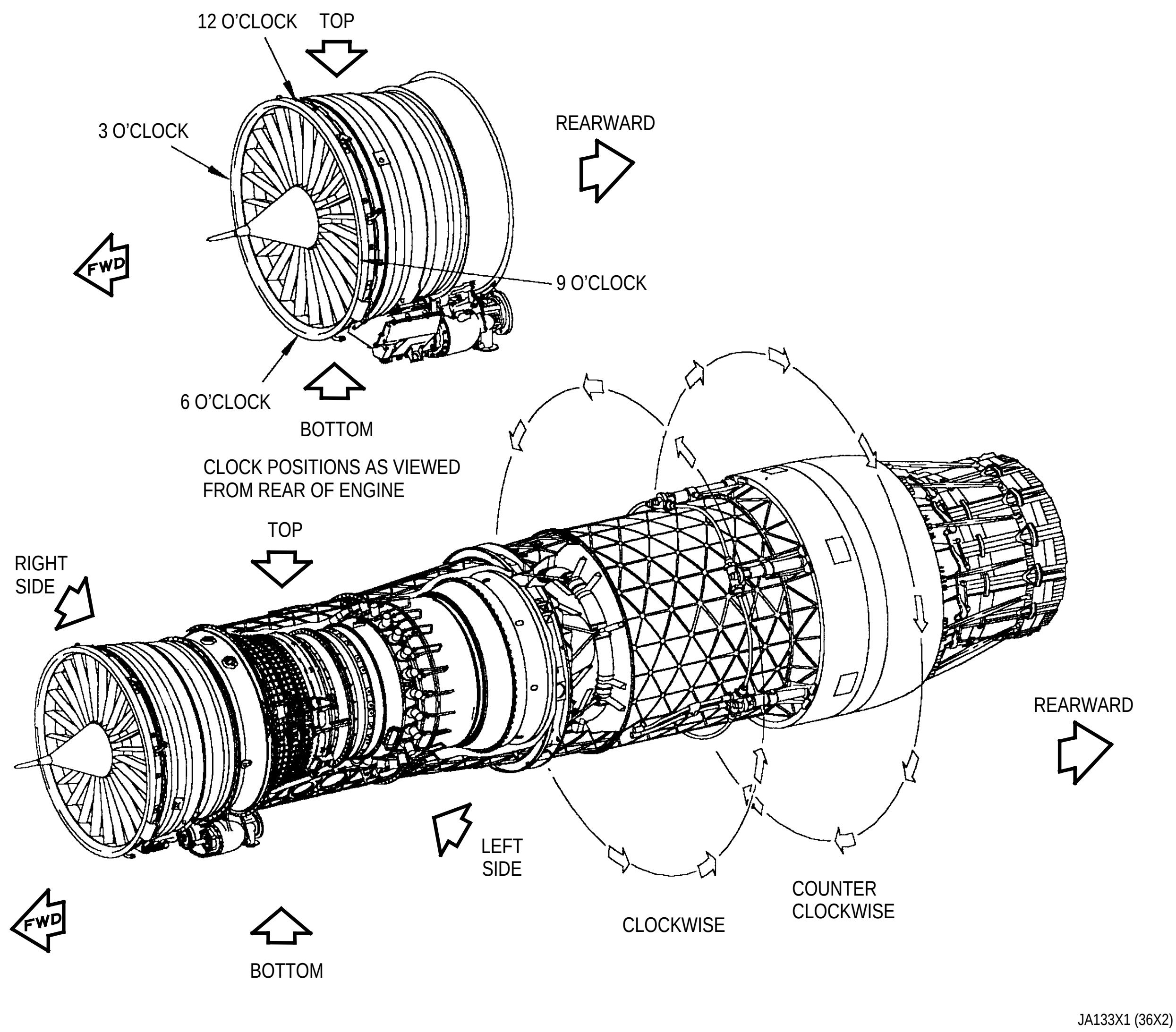
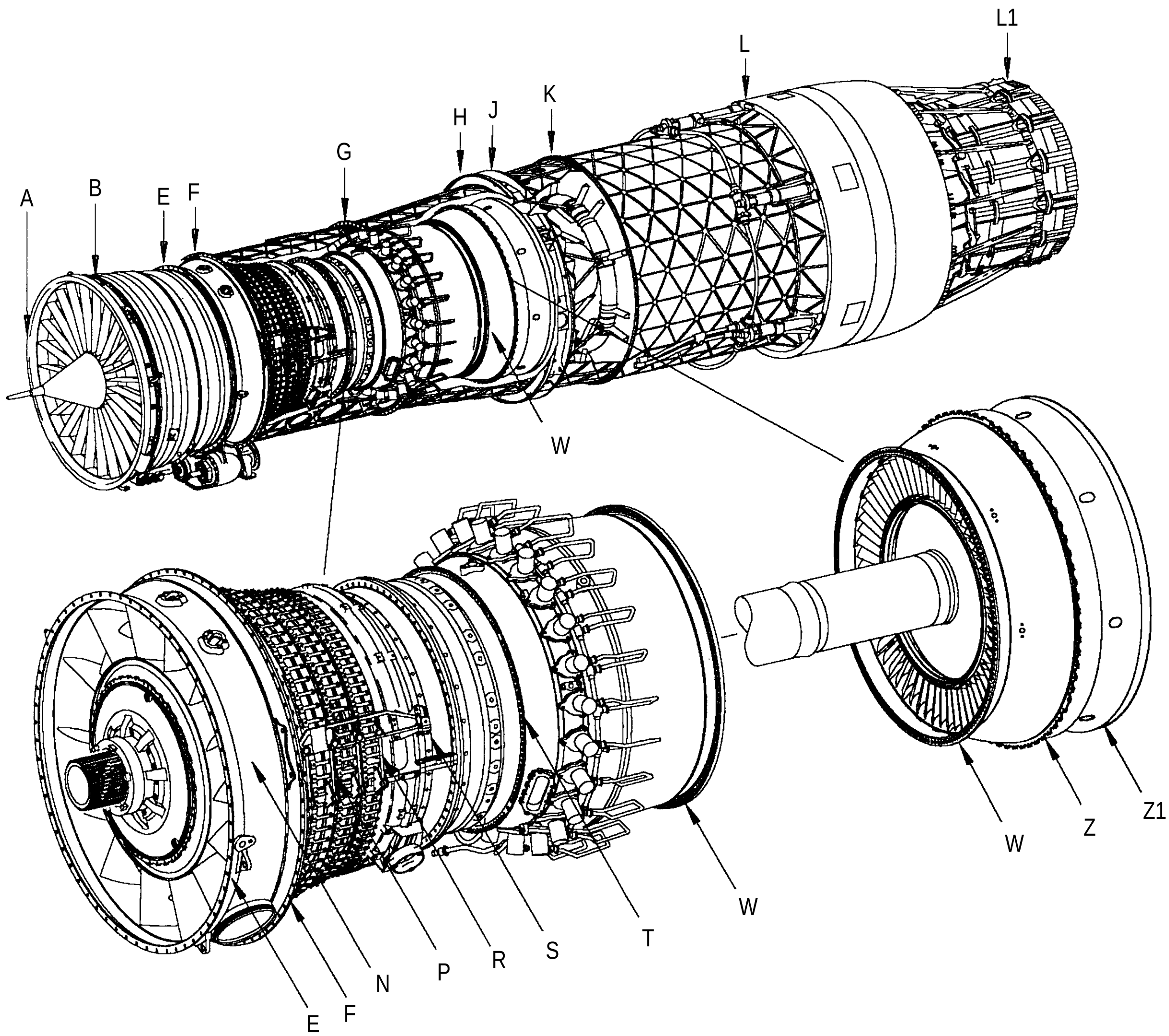


Figure 1. Directional References

3. ENGINE EXTERNAL FLANGES.
(See Figure 2.)

a. Engine flanges provide locations for attachment of brackets, external accessories, and support equipment.

b. Each flange is referred to by a letter designation (B through Z1).



A–B INLET FAN CASE
B–E FAN CASE
E–F COMPRESSOR INTERMEDIATE CASE
F–G FRONT OUTER FAN DUCT
G–K REAR FAN DUCT
H–J REAR MOUNTING FLANGES
K–L AUGMENTOR COMBUSTION CHAMBER DUCT
L–L1 AUGMENTOR NOZZLE
E–N COMPRESSOR INTERMEDIATE CASE AND REAR COMPRESSOR VARIABLE INLET GUIDE VANE AND CASE ASSEMBLY
N–P REAR COMPRESSOR 4TH STAGE VARIABLE STATOR AND CASE ASSEMBLY
P–R REAR CPMPRESSOR 5TH STAGE VARIABLE STATOR AND CASE ASSEMBLY
R–S 7TH STAGE COMPRESSOR CASE ASSEMBLY
S–T 10TH – 13TH STAGE COMPRESSOR CASE ASSEMBLY
T–U DIFFUSER CASE
U–W FRONT TURBINE CASE
W–Z REAR TURBINE CASE
X–Y REAR MOUNT FLANGE INTEGRAL WITH REAR TURBINE CASE
Z–Z1 TURBINE EXHAUST CASE

JA135X2 (48X2)

Figure 2. Engine External Flanges

4. ENGINE STATIONS.
See Figure 3.)

a. Engine station designations provide another means of pinpointing locations on the engine.

b. Each station is identified by number (0 through 8).

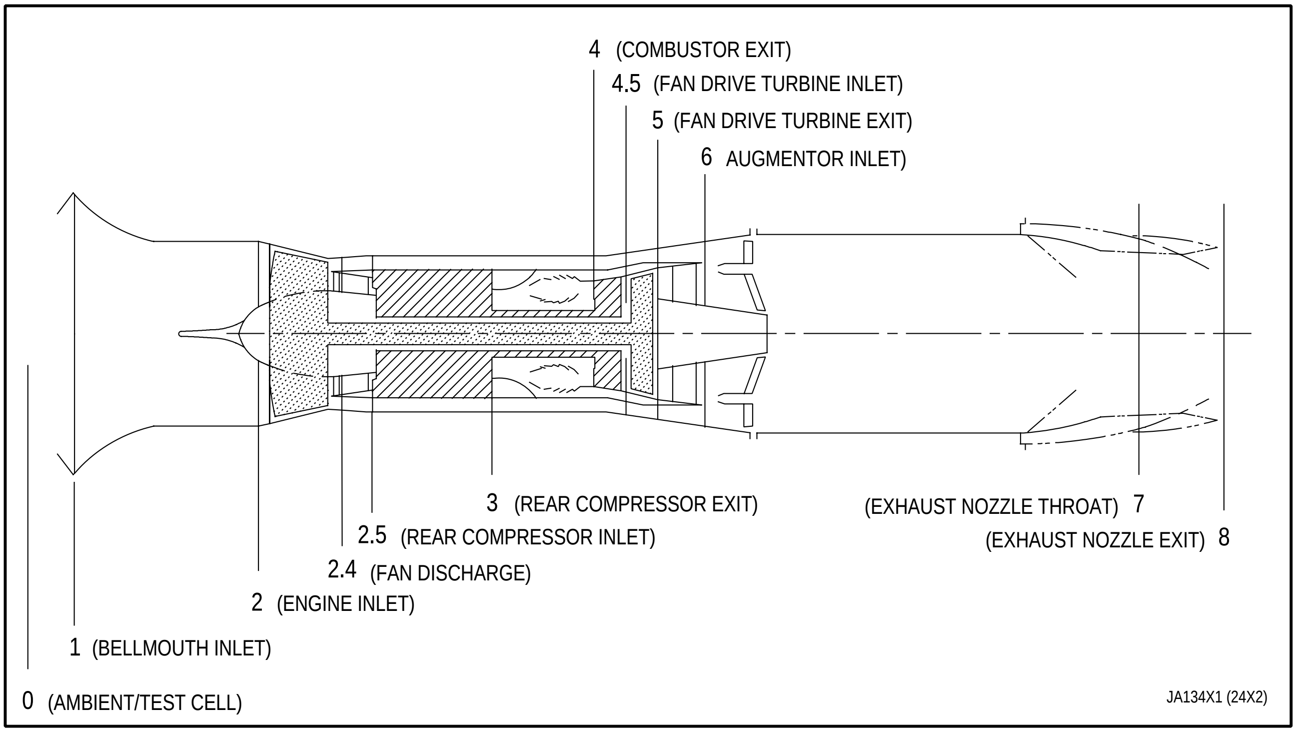


Figure 3. Engine Stations - Identification and Location

5. MAIN BEARING NUMBERING.

(See Table 1.)

a. Main engine bearings are referred to by number. Table 1 provide the nomenclature, type, and location of these bearings.

Table 1. Main Bearing Numbering

Number	Bearing Name	Type	Location
1	Fan Front	Roller	Fan Inlet case; No. 1 hub
2	Fan rear	Ball	Intermediate case; turbine shaft coupling (No. 2 bearing and coupling assembly)
3	Rear compressor	Ball	Intermediate case; 6th front stage compressor disk and hub assembly
4	Rear compressor	Roller	Diffuser case; rear turbine front compressor driveshaft
5	Fan turbine rear	Roller	Rear turbine case; front compressor drive turbine shaft

6. BASIC ENGINE INFORMATION.

(See Table 2.)

a. Model ---------------------- F100-PW-229
b. Type ---------------------- Axial flow, turbofan gas turbine with augmentor

c. Compressor

(1) Front (N1) - low pressure ------ Three stages
(2) Rear (N2) - high pressure ------ Ten stages

d. Turbine

(1) First and second stages ------ Drive rear compressor
(2) Third and fourth stages ------ Drive front compressor
(3) Direction of rotation -------- Clockwise, viewed from rear

e. Combustor

(1) Number ------------------ One
(2) Type ------------------- Annular

f. Weight (approximate pounds)

(1) F100-PW-229 -------------- 3784(F-15)
3819(F-16)

g. Dimensions (at room temperature)

(1) Length ------------------ 208.33 inches
(2) Diameter ---------------- 46.50 inches

NOTE

Primary fuel, NATO F-40, may not contain MIL-I-25017 corrosion inhibitor at some locations. Alternate fuels, Jet A, Jet A-1, Jet B, and NATO F-35, do not contain MIL-I-25017 corrosion inhibitor. NATO F-34, NATO F-43, and NATO F-44 may or may not contain MIL-I-25017 corrosion inhibitor. Duration of engine operation without corrosion inhibitor is not limited.

h. Fuel specifications - - - - - - - - - - - - - - - - - Primary: MIL-T-5624, Grade JP-4 (NATO F40)

Alternates: MIL-T-83133, Grade JP-8 MIL-T-5624, Grade JP-5 ASTM-D-1655 (Jet A, Jet A-1, or Jet B) NATO F-34, F-35, F-43, or F-44

i. Oil specification - - - - - - - - - - - - - - - - - - MIL-L-7808

j. Oil tank capacities (gallons) - - - - - - - - - -

(1) Usable oil - - - - - - - - - - - - - - - - - - - 3.1
(2) Residual oil - - - - - - - - - - - - - - - - - 0.3
(3) Expansion oil volume - - - - - - - - - - - - 1.0

k. Augmentor nozzle actuation cylinders - - - - - 5

l. Shipping information. (See table 2.)

Table 2. Shipping Information

Item	Dry weight (Pounds)	Container Weight (Pounds)	Total Weight, (Pounds)[1]	Container Dimensions, L x W x H (Inches)
Inlet/fan module	435	842	1277	55 x 55 x 43
Core engine module	1510	1874	3384	101 x 61 x 65
Fan drive turbine module	460	1045	1505	92 x 46 x 51
Augmentor module	560	1590	2105	113 x 61 x 69
Gearbox module	96	187	283	35 x 33 x 25
Rear compressor drive turbine rotor and stator	320	474	794	41 x 41 x 29
Combustion chamber	87	70	157	31 x 31 x 21
Main fuel control	63	117	180	34 x 34 x 21
Augmentor fuel pump	27	69	96	25 x 25 x 24
Main fuel pump	33	71	104	24 x 24 x 28
Augmentor fuel control	59	-	-	-
Engine assembly	3784(F-15)	1302[2] 1542[3]	5086 5326	205 x 59 x 87
	3819(F-16)	1302[2] 1542[3]	5121 5361	205 x 59 x 87

(1) Total weight does not include entrapped fluids, desiccants, preservatives, etc.

(2) Air Logistics 3000 Trailer

(3) Air Logistics 3000E Trailer

7. ENGINE AND MODULE IDENTIFICATION PLATE.

(See Figure 4.)

a. Engine and module identification plates contain blocks for the following information:

- Module name
- Engine model number
- Contract identification (engine contract number)
- Engine or module serial number
- Manufacturer’s code identification and part number

b. See figure 4 for location of data plates.

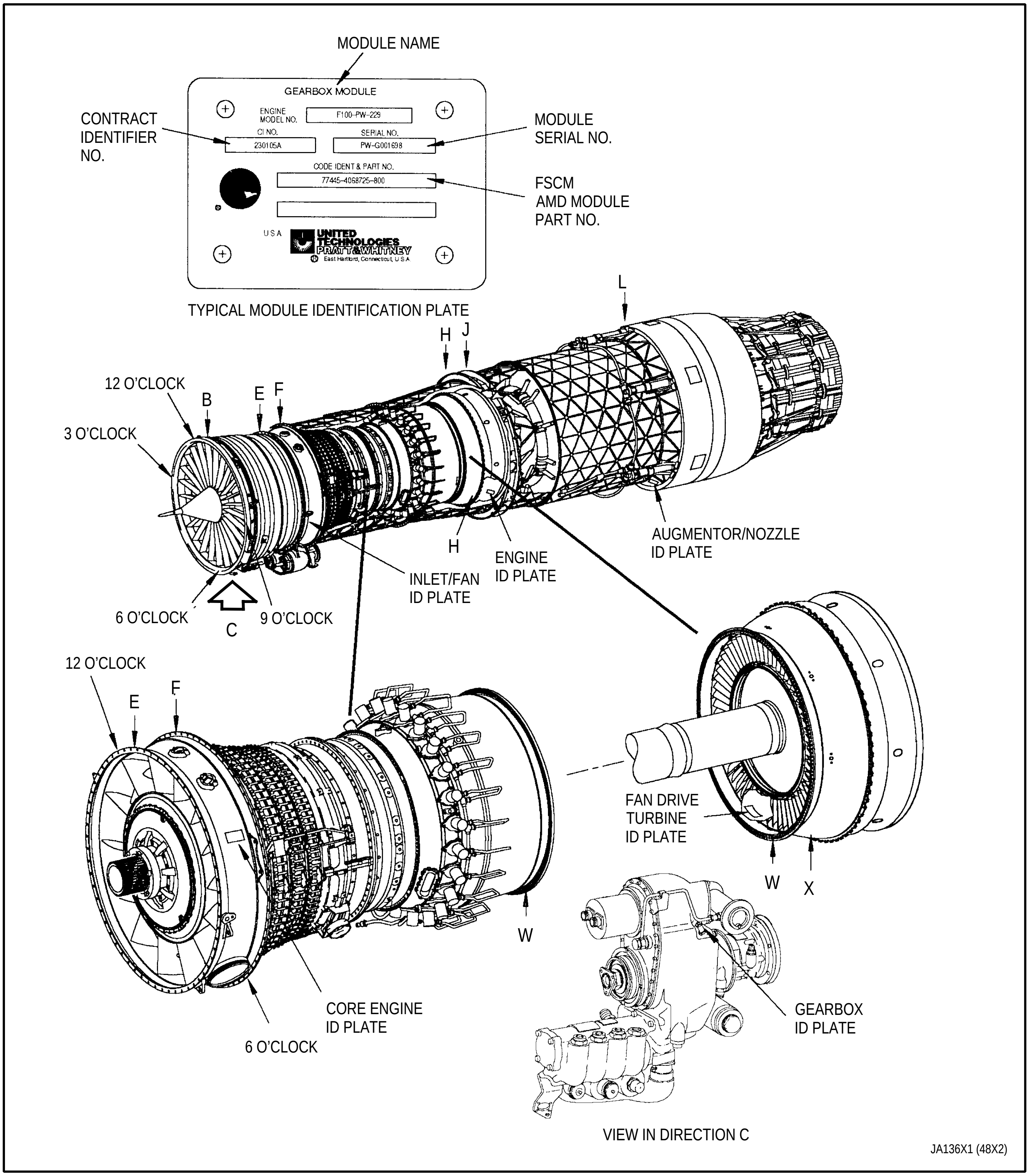


Figure 4. Engine and Module Identification Plate Location

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - BASIC ENGINE FEATURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the basic F100-PW-229 engine and the modular concept.

2. ENGINE DESCRIPTION.

a. The F100-PW-229 engine is:

- low bypass
- high compressor ratio
- twin spool
- turbofan
- mixed flow augmentor

b. The engine has an advanced design with high thrust to weight ratio required for high performance aircraft with subsonic and supersonic missions.

c. The design includes variable vanes in the front compressor inlet and rear compressor inlet for improved performance.

d. Other features include:

- annular ram induction combustor for optimum combustion
- mixed flow augmentor for variable thrust
- light weight balanced beam nozzle
- engine control system incorporating a main fuel control and a augmentor fuel control
- digital electronic engine control engine monitoring system
- secondary control mode for emergency operational capability
- engine diagnostic unit to collect and store time, cycle, performance and anomaly data.
- gear-type main fuel pump
- core module split compressor case
- FLOATWALL® combustor liner

3. MODULAR CONCEPT.

(See Figure 1 and Table 1.)

a. The basic engine has functionally and physically associated parts that are removable as units. These units are called modules.

b. The five modules in the F100-PW-229 engine are:

- inlet fan
- core engine
- fan drive turbine
- augmentor duct and nozzle
- gearbox

c. Modules make it possible to return an engine to service immediately by installing a serviceable module, instead of withholding an entire engine from service to repair or replace a relatively minor subassembly.

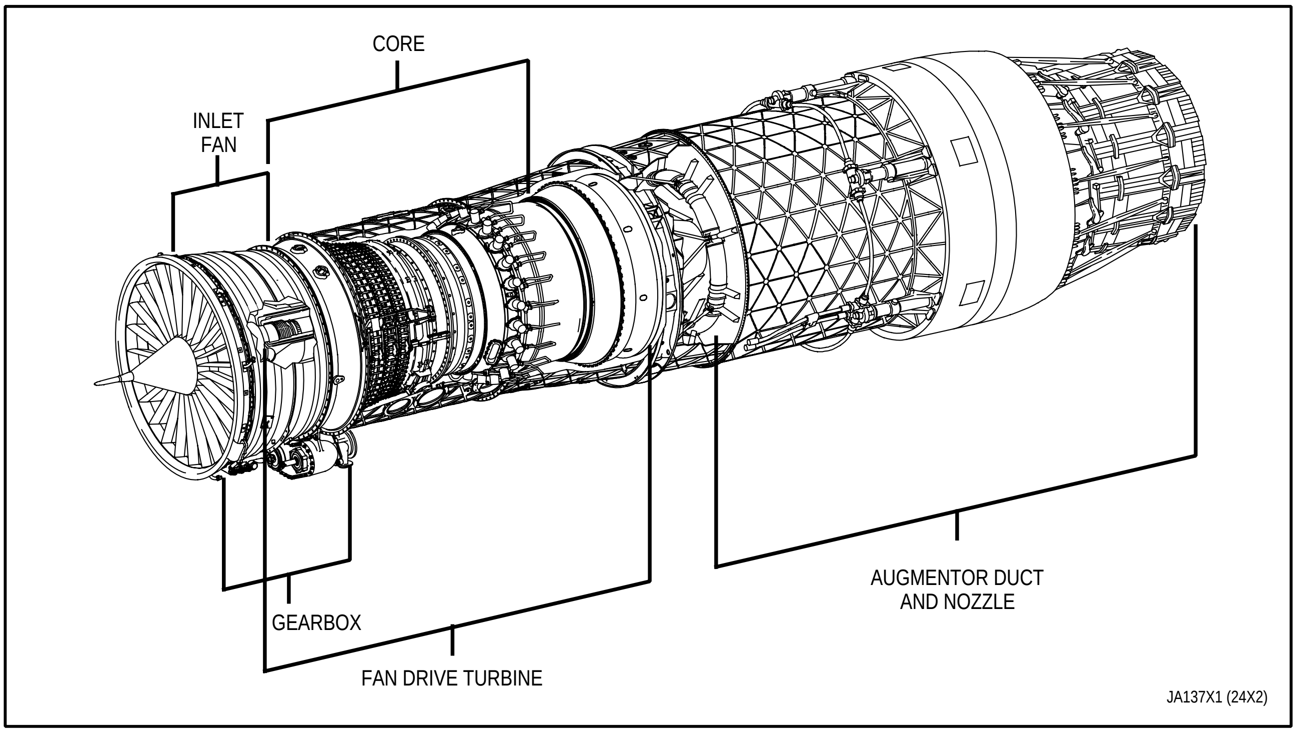


Figure 1. Engine Modules - Identification

d. The modular concept, however, does not prohibit repair or replacement of a subassembly or detail part, if this is determined more satisfactory.

e. Table 1 divides each module into its major components.

Table 1. Engine Modules and Their Major Module Parts

Module	Major Module Parts
Inlet Fan	• Fan inlet case • Compressor inlet variable vane (CIVV) control and cylinder assembly • Front compressor rotor and stator assembly • No. 1 bearing, No. 1 bearing housing and No. 1 bearing pressure and scavenge tube assemblies • Quad N1 sensor
Core Engine	• Compressor intermediate case • Split compressor case • No. 2 bearing and coupling assembly • No. 3 bearing and gear assembly • Rear compressor rotor and stator assembly • Fuel nozzles and left and right fuel supply manifolds • Diffuser case assembly • Combustion chamber assembly • No. 4 bearing • Rear compressor drive turbine rotor and stator assembly
Fan Drive Turbine	• Front compressor drive turbine rotor and stator assembly • Front compressor drive turbine shaft • Rear turbine case and duct set • Turbine exhaust case • No. 5 bearing
Augmentor Duct and Nozzle	• Augmentor duct • Augmentor combustion chamber liner • Augmentor nozzle actuators • Augmentor nozzle assembly
Gearbox	• Main gearbox assembly • Main pump assembly • Reduction gearbox • Oil filter • Breather pressurizing valve

4. NONMODULAR PARTS.

a. Although five modules contain the major engine subassemblies, five modules together do not make a complete engine. Parts that are not contained in a module can be replaced more easily on an individual basis than as part of a module.

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - INLET/FAN MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 14	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains a description of the inlet fan module and its major parts.

2. INLET/FAN MODULE.

(See Figure 1.)

a. The inlet fan module consists of:

- fan inlet case (includes anti-icing manifold)
- compressor inlet variable vane (CIVV) control, cylinder, and CIVV assembly
- front compressor rotor and stator assembly (includes drum rotor)
- compressor drum rotor
- No. 1 bearing, No. 1 bearing housing, and No. 1 bearing pressure and scavenge tube assemblies

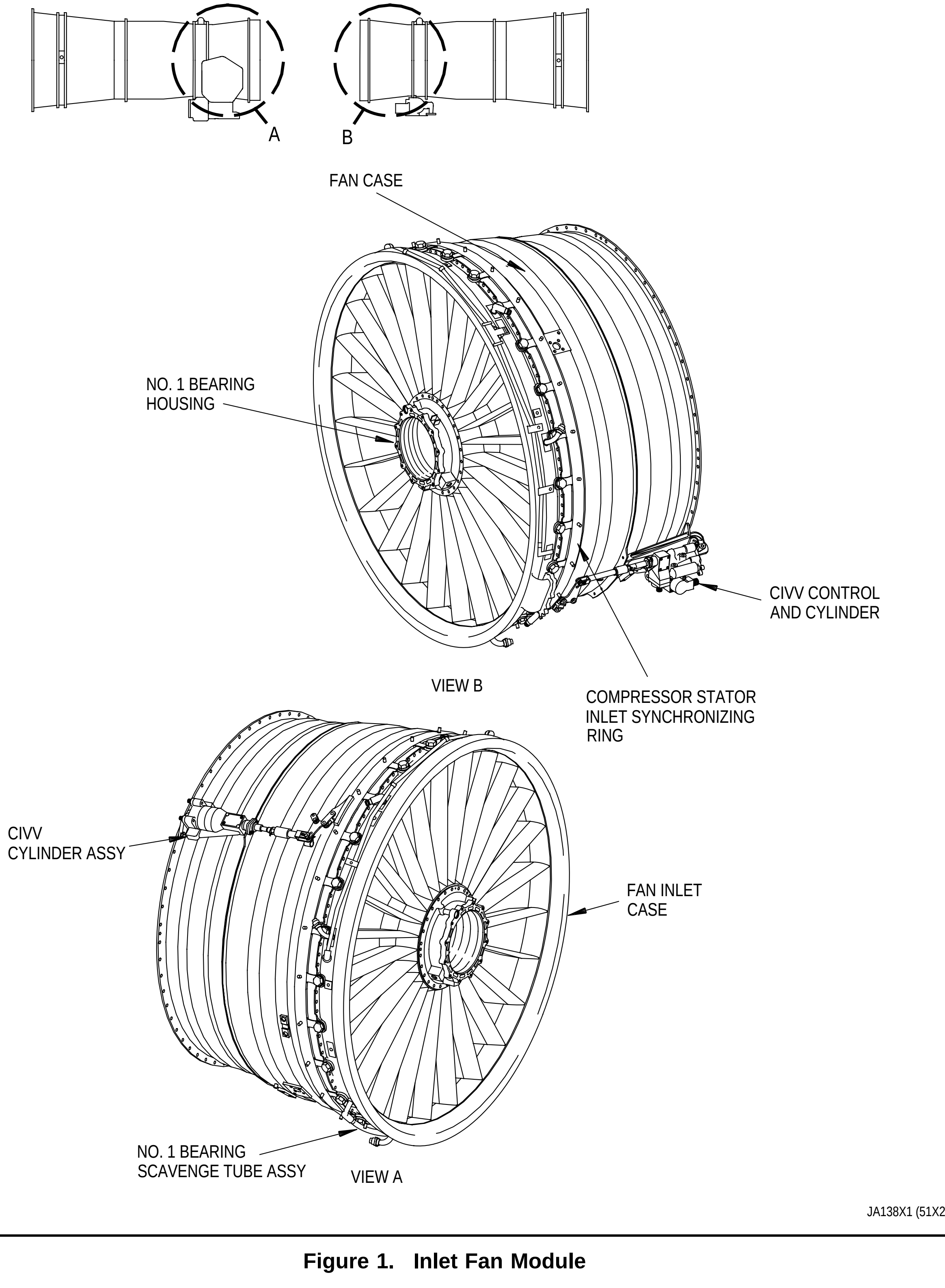


Figure 1. Inlet Fan Module

3. FAN INLET CASE.
(See Figure 2.)

a. The fan inlet case contains 25 compressor inlet vanes. Each vane is made in two segments.

(1) The leading edge is fixed and welded to fan inlet case. It supports No. 1 bearing compartment.

(2) The trailing edge is moveable (variable) so its angle can be varied according to N1 speed and inlet temperature.

(a) The trailing edge is attached to fan inlet case ID and front compressor stator inlet shroud OD.

(b) The trailing edge is also mechanically linked to compressor inlet variable vane (CIVV) control and cylinder through the compressor stator inlet synchronizing ring.

b. Four compressor inlet vanes are hollow and contain No. 1 bearing pressure and scavenge tubes. Four additional compressor inlet vanes are hollow and contain quad N1 sensor cables.

c. The anti-icing manifold funnels air from the 13th stage compressor case to the leading edge vanes.

d. The leading edge vanes are hollow so anti-icing air can be fed through them to the nose cone (nonmodular part) and out through slots into the engine air stream.

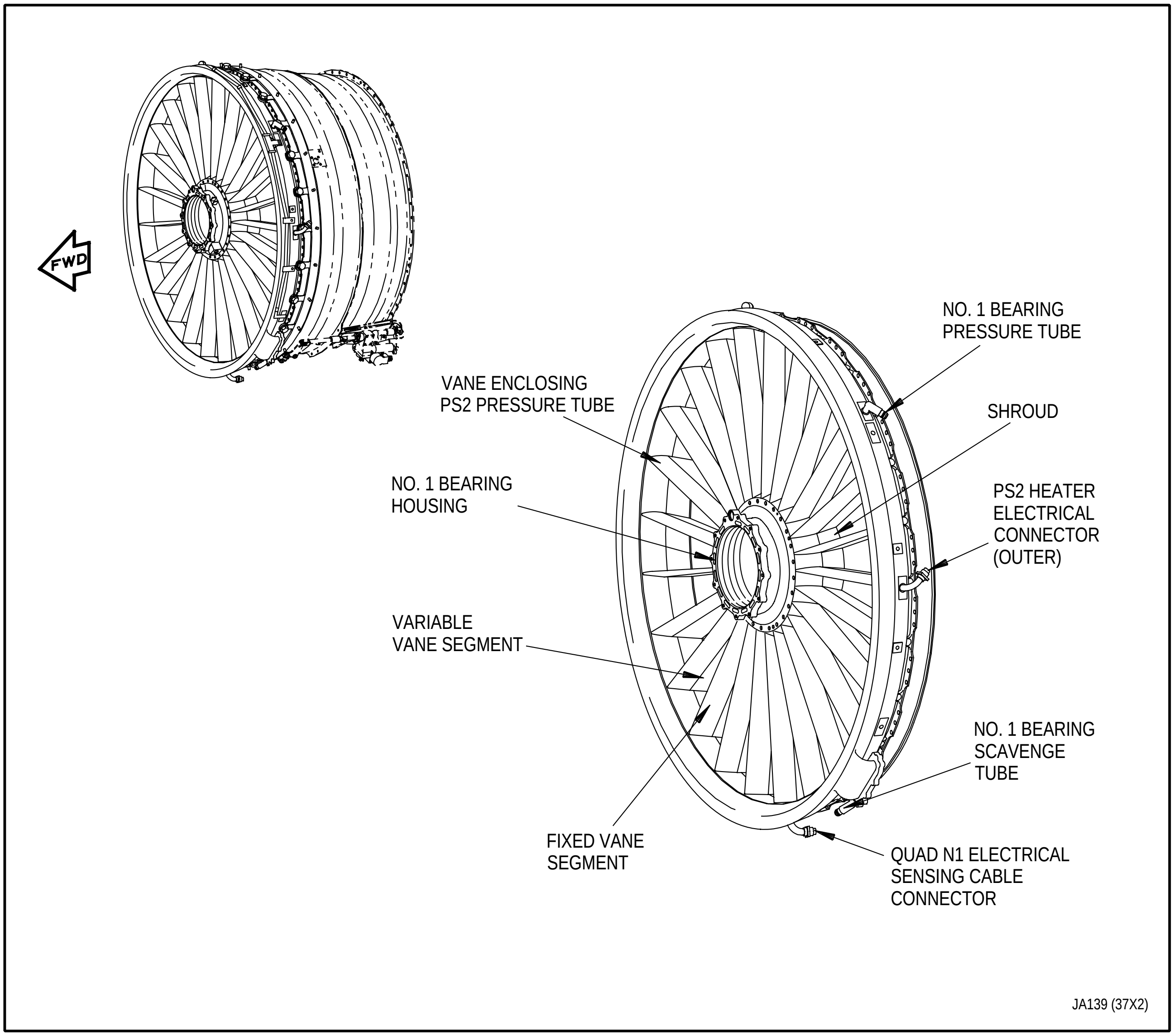


Figure 2. Fan Inlet Case

4. COMPRESSOR INLET VARIABLE VANE CONTROL AND CYLINDER ASSEMBLY.
(See Figure 3.)

a. When the digital electronic engine control (DEEC) senses that the compressor inlet variable vanes need repositioning, it sends a signal to the compressor inlet variable vane (CIVV) control and cylinder.

b. The CIVV control and cylinder and its slave, the CIVV cylinder, respond by modulating fuel pressure through the pressure extend and retract tubes.

c. Both cylinders are attached through bellcranks to the compressor stator inlet synchronizing ring which pivots the vanes equally and in unison.

d. Both cylinders are mounted across the front compressor rotor and stator assembly parallel to the horizontal centerline. The CIVV control and cylinder is located at the 8 o’clock position, the CIVV cylinder is at the 2 o’clock position.

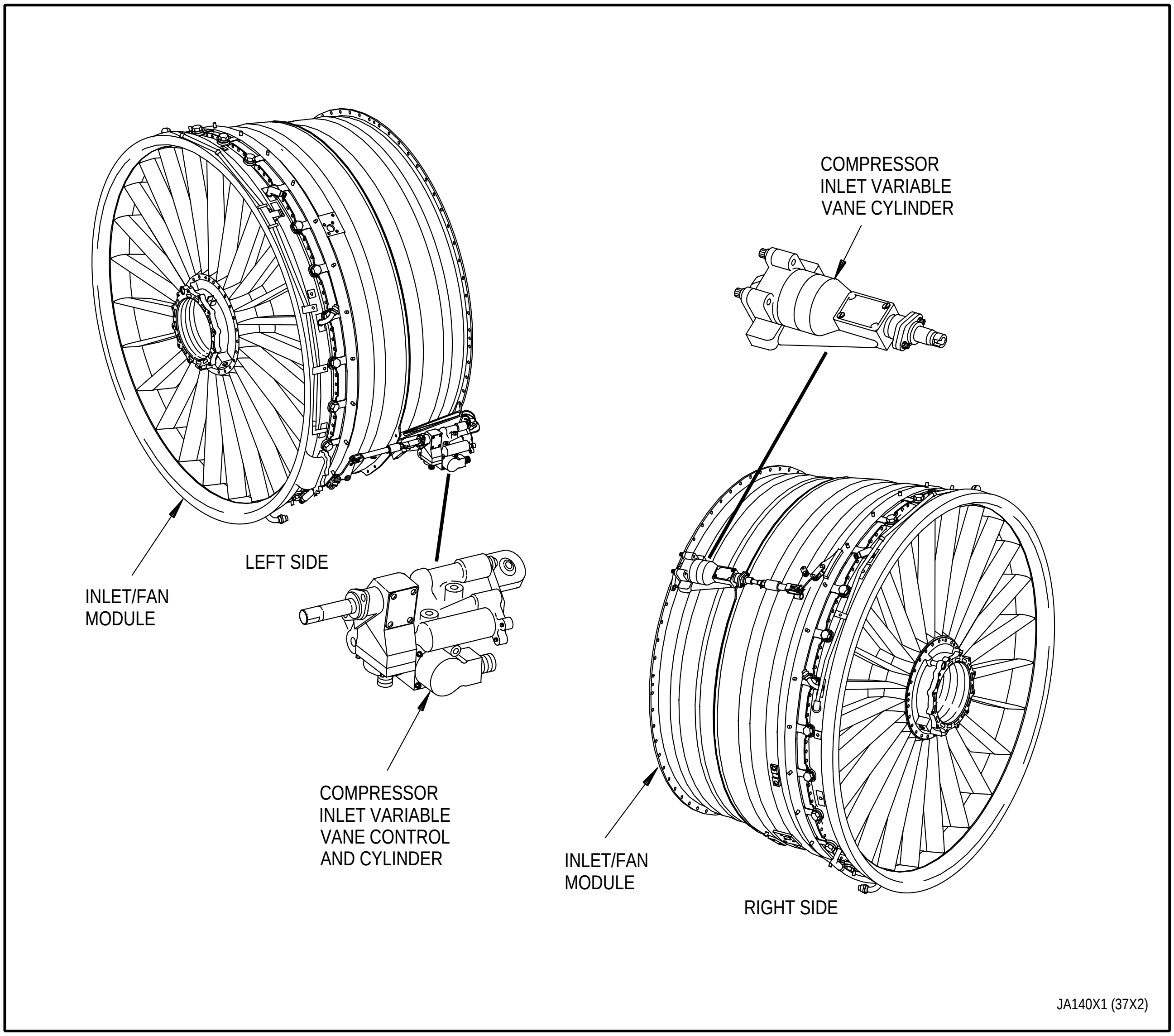


Figure 3. Compressor Inlet Variable Vane Control and Cylinder and Compressor Inlet Variable Vane Linear Actuating Cylinder

5. FRONT COMPRESSOR ROTOR AND STATOR ASSEMBLY.
(See Figure 4.)

a. The front compressor rotor and stator assembly contains three stages of blades and two stages of vanes numbered consecutively from the fan inlet case.

b. Blades in all three stages are moment weighted (weight of blade with its center of gravity taken into consideration). These blades can be replaced without rebalancing the drum rotor.

c. The 1st and 2nd stage compressor stator vanes are contained in the fan case.

d. The front compressor rotor and stator assembly can be repaired in two ways.

(1) After removing the fan inlet case, the 1st and 2nd stage compressor rotor blades and the 1st and 2nd stage stator assemblies can be removed with the module still on the engine.

(2) After removing the inlet fan module, the 3rd stage compressor rotor blades and 3rd stage lock ring can be removed from the rear.

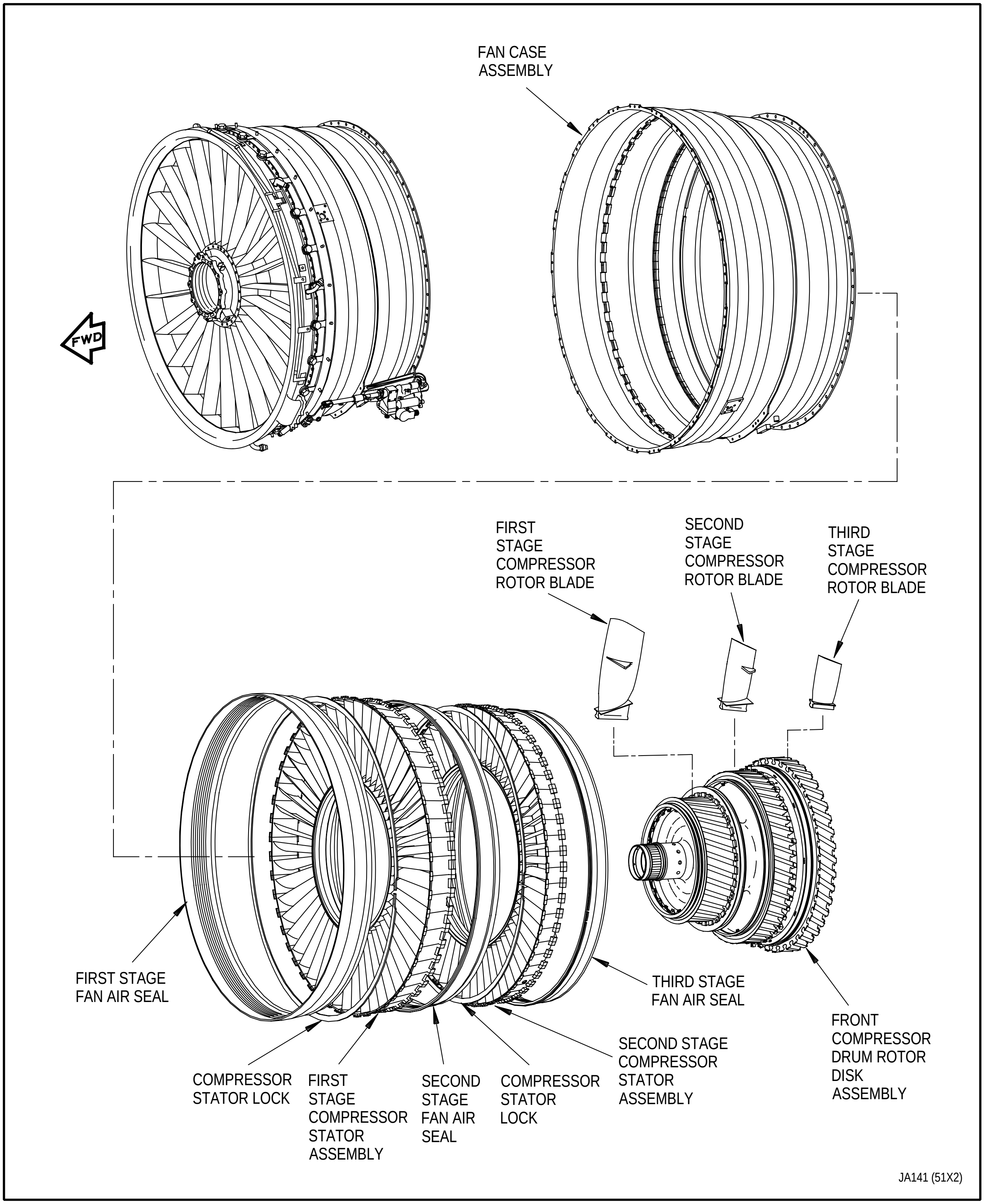


Figure 4. Front Compressor Rotor and Stator Assembly

6. No. 1 BEARING, No. 1 BEARING HOUSING AND No. 1 BEARING SCAVENGE TUBE ASSEMBLIES.

(See Figures 5, 6, and 7.)

a. The No. 1 bearing and the No. 1 bearing housing form the No. 1 bearing compartment. The No. 1 bearing compartment is contained in the front compressor stator inlet shroud. It is supported by the leading edge vanes of the fan inlet case.

b. The No. 1 bearing assembly supports the front compressor rotor and stator assembly. (See figure 5.) The bearing assembly consists of:

- inner race
- rollers
- outer race

c. The No. 1 bearing housing contains and supports the No. 1 bearing. (See figures 5 and 6.) The housing is made up of:

- spring loaded No. 1 bearing carbon seal
- No. 1 bearing seal ring

d. Lubricating oil is sent to the No. 1 bearing compartment through the No. 1 bearing pressure tube assembly. The 1 bearing pressure tube passes in and through one of the hollow leading edge vanes in the fan inlet case. (See figure 7.)

e. Oil is collected from the No. 1 bearing compartment by three oil scavenge tubes. These tubes also pass in and through three hollow leading edge vanes in the fan inlet case.

f. The No. 1 bearing compartment breathes through its oil scavenge lines.

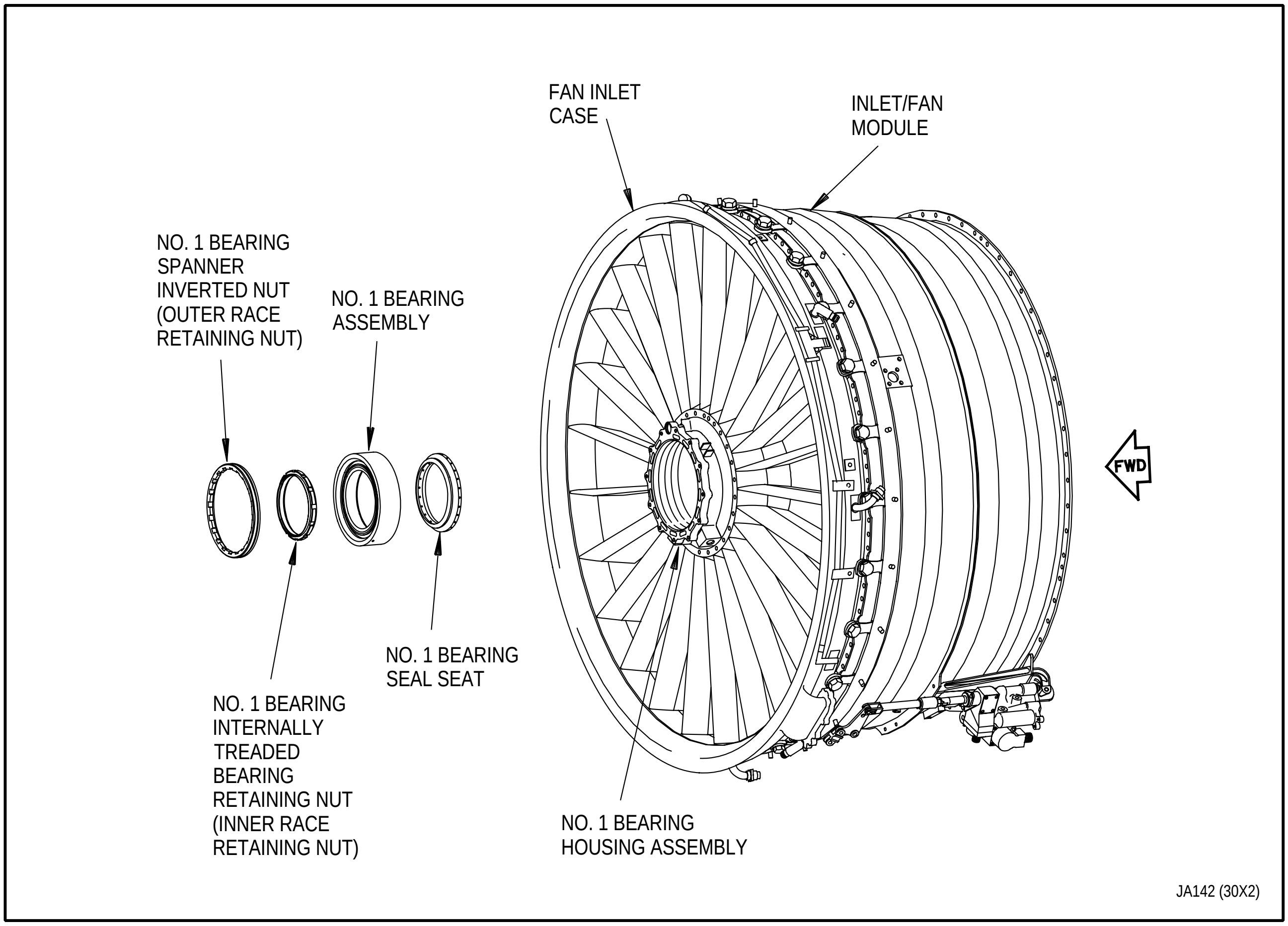


Figure 5. No. 1 Bearing Assembly

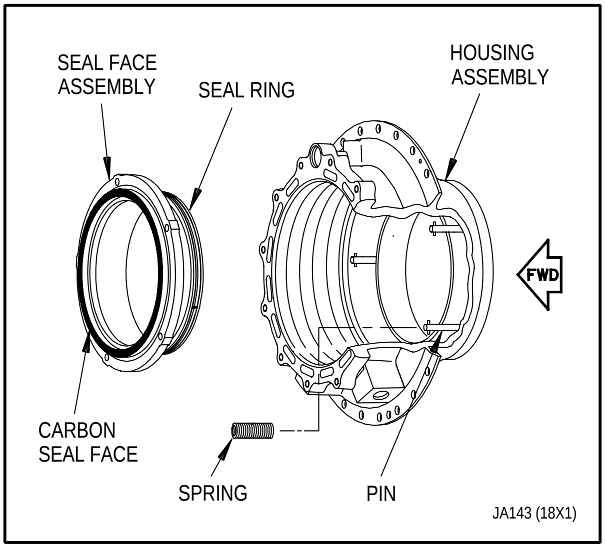


Figure 6. No. 1 Bearing Housing

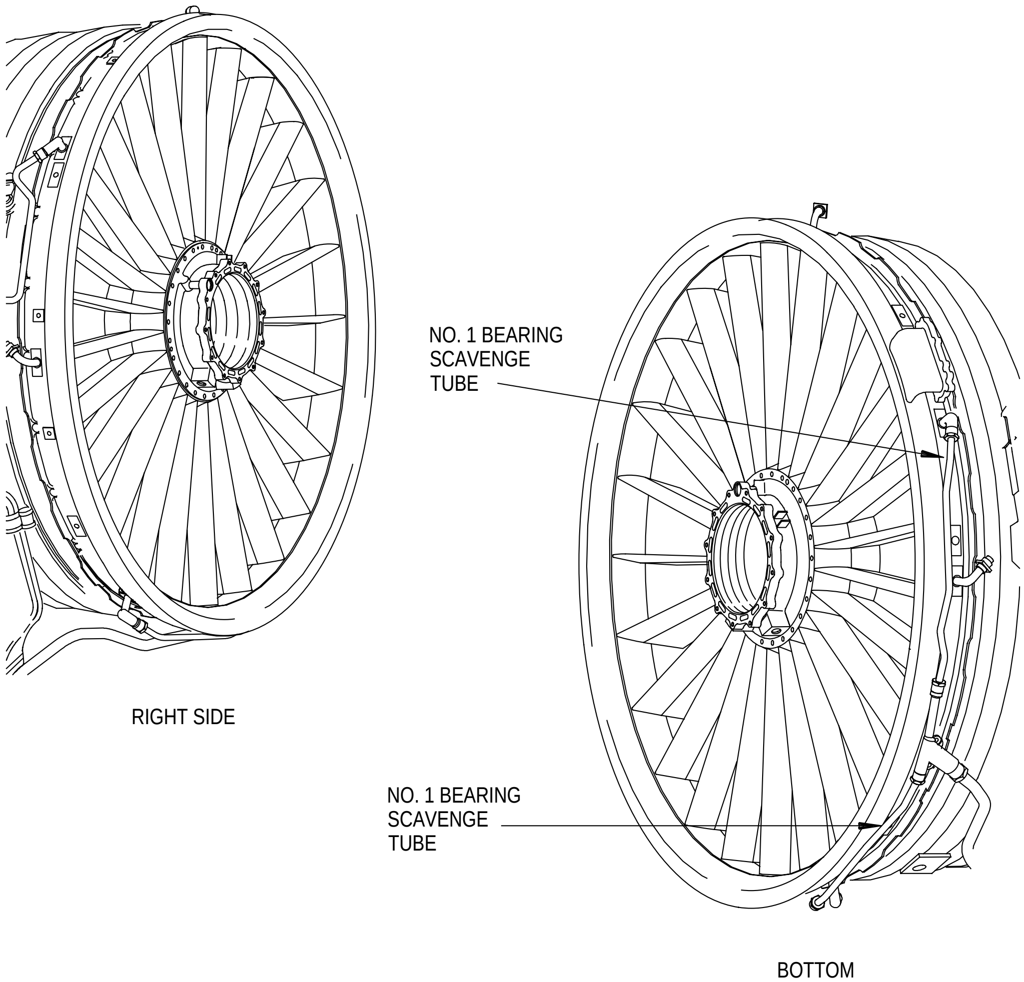


Figure 7. No. 1 Bearing Scavenge Tubes

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

CORE ENGINE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 32

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 31	0				
32 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains a description of the core engine module and its major parts.

2. CORE ENGINE MODULE.

(See Figure 1.)

a. The core engine module consists of:

- compressor intermediate case
- No. 2 bearing and coupling assembly
- No. 3 bearing and gear assembly
- rear compressor rotor and stator assembly
- fuel nozzles and left and right fuel supply manifolds
- diffuser case assembly
- combustion chamber assembly
- No. 4 bearing
- rear compressor drive turbine rotor and stator assembly

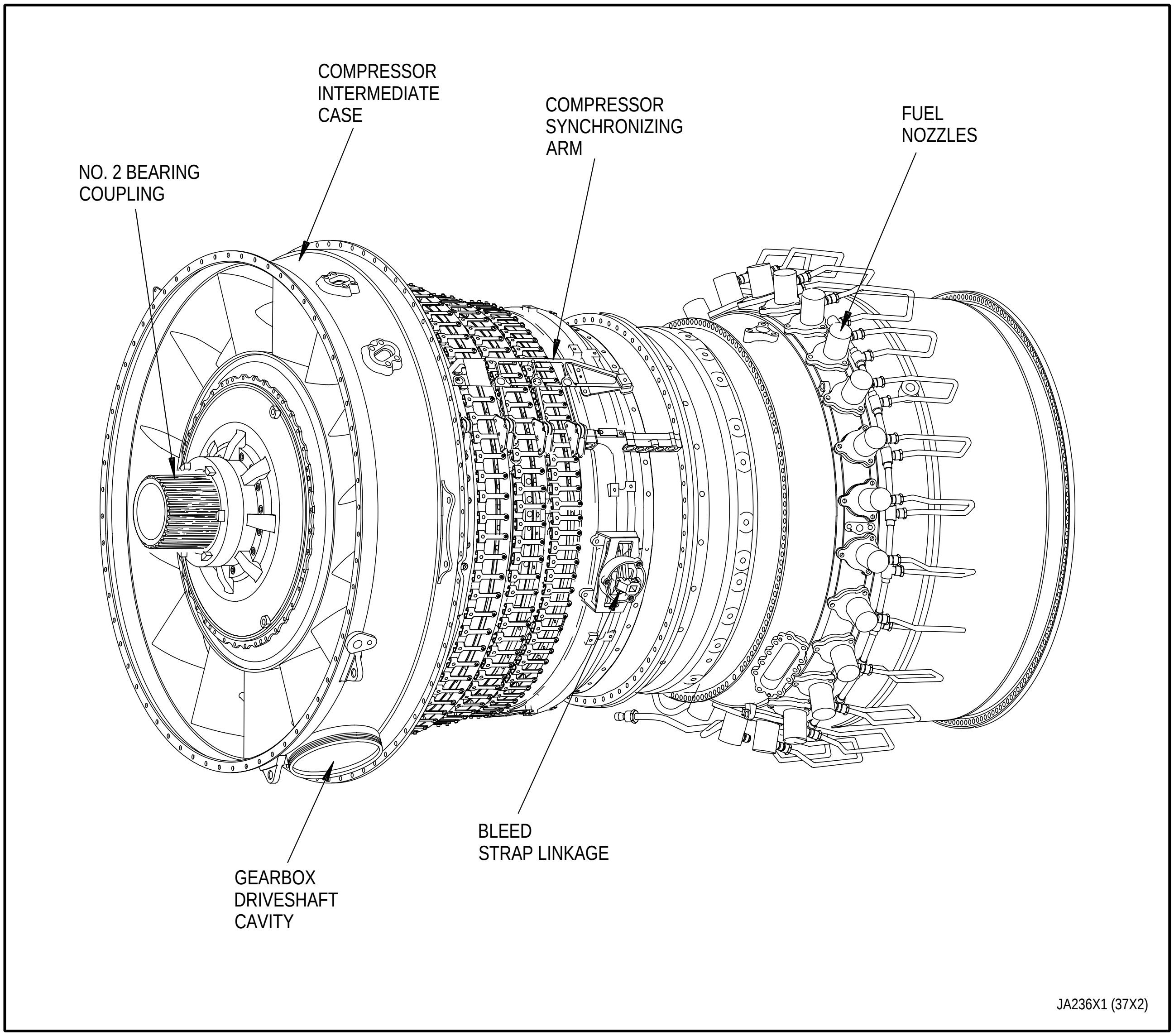


Figure 1. Core Engine Module

3. COMPRESSOR INTERMEDIATE CASE.

(See Figure 2.)

a. The compressor intermediate case contains 14 hollow radial struts. These struts:

- are aerodynamically designed
- transfer loads from No. 2 and 3 bearings to engine outer cases
- contain oil pressure tubes for No. 2 and 3 bearing compartment at 2 o’clock, 3 o’clock, and 11:30 o’clock positions
- house the gearbox driveshaft (6 o’clock strut)

b. The compressor intermediate case also:

- contains an airflow splitter which divides airflow from the front compressor into fan airflow and primary airflow
- houses the No. 2 bearing and coupling assembly and No. 3 bearing and gear assembly
- contains a borescope port for inspection (6:30 o’clock position) (AP7)
- allows oil from the No. 2 and 3 bearing compartment to be scavenged through the gearbox driveshaft cavity
- contains rear compressor stator variable inlet vanes
- contains the 3rd stage stator

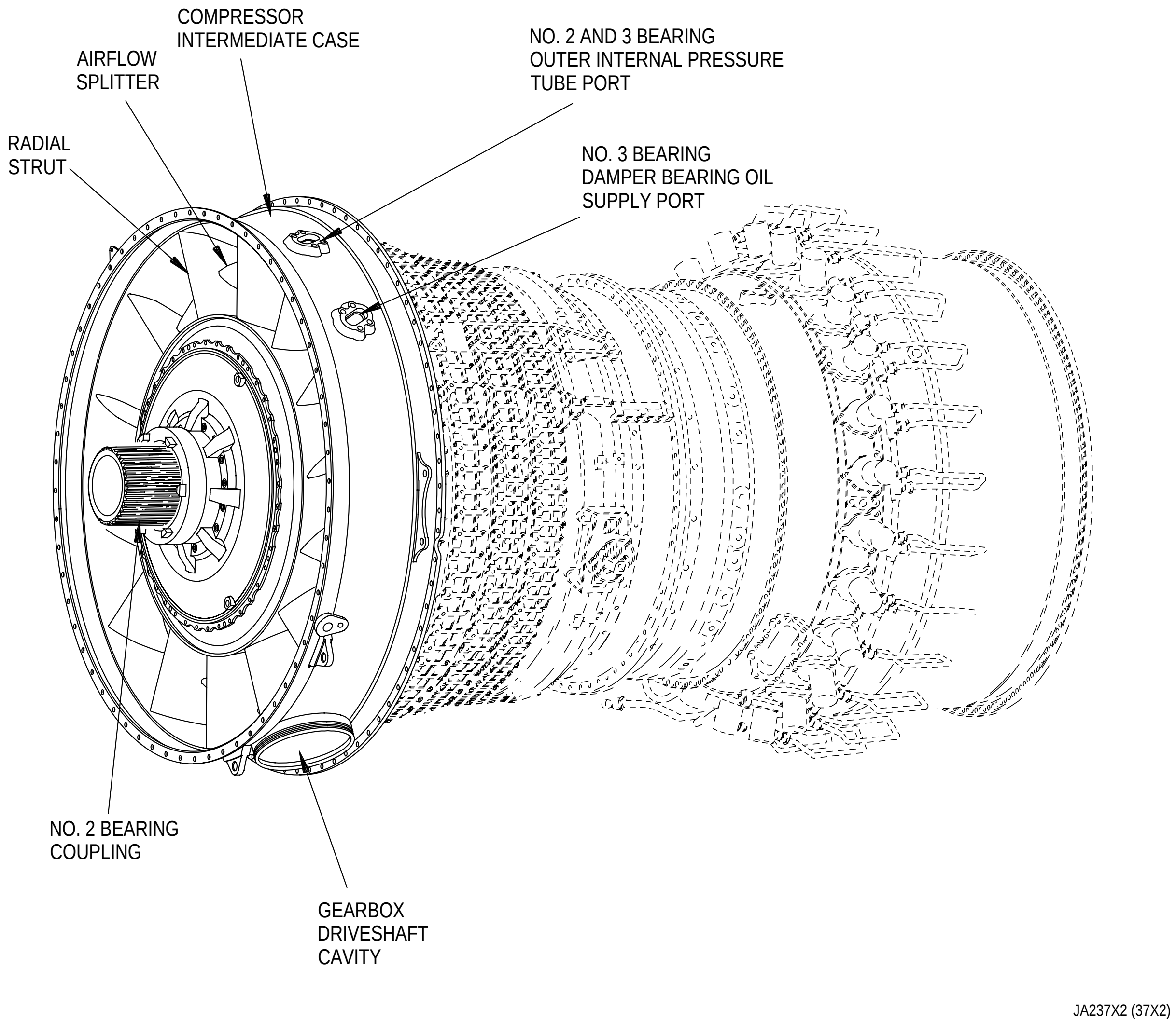


Figure 2. Compressor Intermediate Case

4. No. 2 BEARING AND COUPLING ASSEMBLY. (See Figures 3 and 4.)

a. The No. 2 bearing and coupling assembly (No. 2 bearing package) is housed in the compressor intermediate case.

b. The major components of the No. 2 bearing and coupling assembly are:

- No. 2 bearing support and No. 2 bearing housing
- turbine shaft coupling
- No. 2 bearing
- gearbox drive bevel gearshaft
- No. 2 bearing front seal assembly and No. 2 and 3 bearing seal assembly

c. The No. 2 bearing is a ball-type thrust bearing with:

- flange mounted outer race
- split inner races

(1) The No. 2 bearing attaches to the turbine shaft coupling.

(2) The OD splines of the bearing and coupling assembly couple and support the front compressor rotor rear hub.

(3) The ID splines couple and support the front of the front compressor drive turbine shaft.

d. The gearbox drive bevel gearshaft engages the gearbox drive bevel gear (part of the No. 3 bearing package).

(1) The gearshaft is mounted on roller and ball bearings at the 6 o’clock position on the No. 2 bearing and coupling assembly

(2) The gearshaft is splined to the gearbox driveshaft which drives the main gearbox.

e. The No. 2 bearing package is bordered, front and rear, by:

- No. 2 bearing front seal assembly
- No. 2 and 3 bearing seal assembly

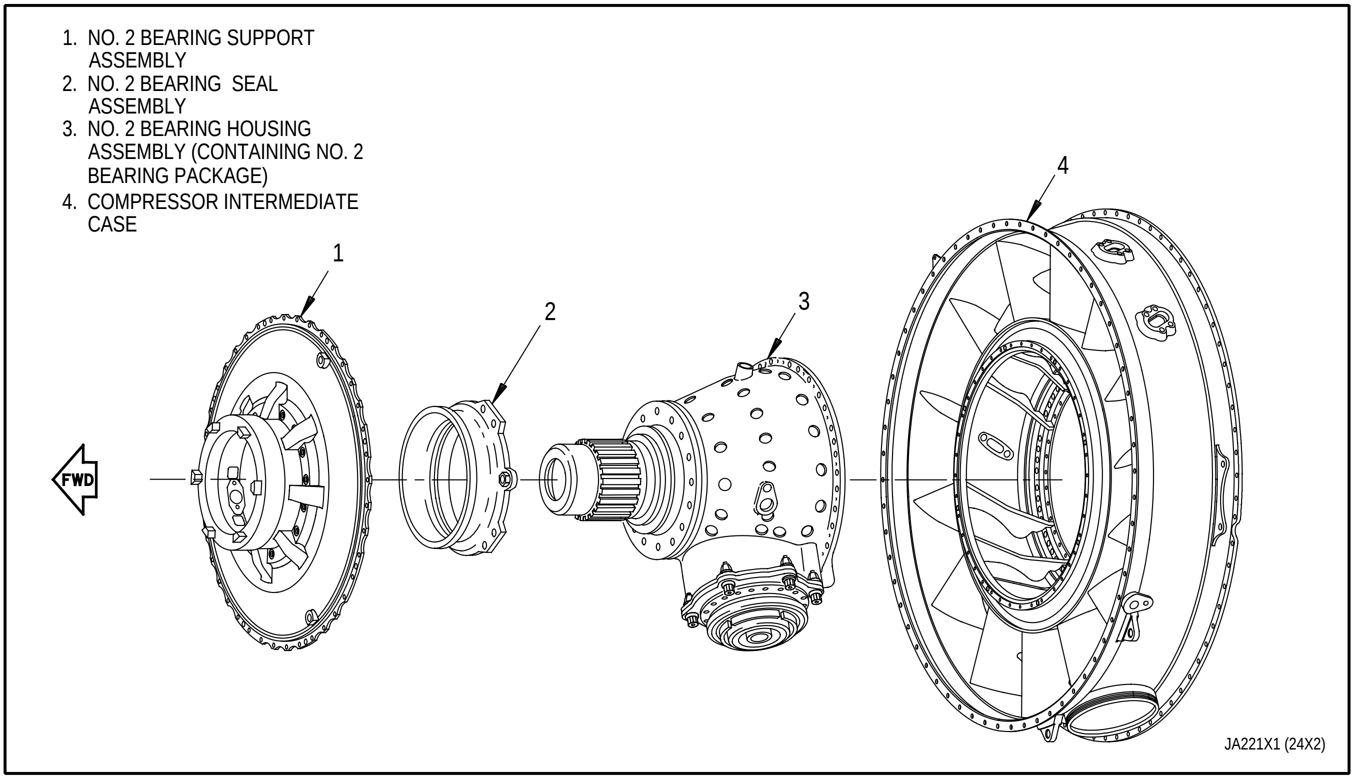


Figure 3. No. 2 Bearing and Coupling Assembly (Sheet 1 of 2)

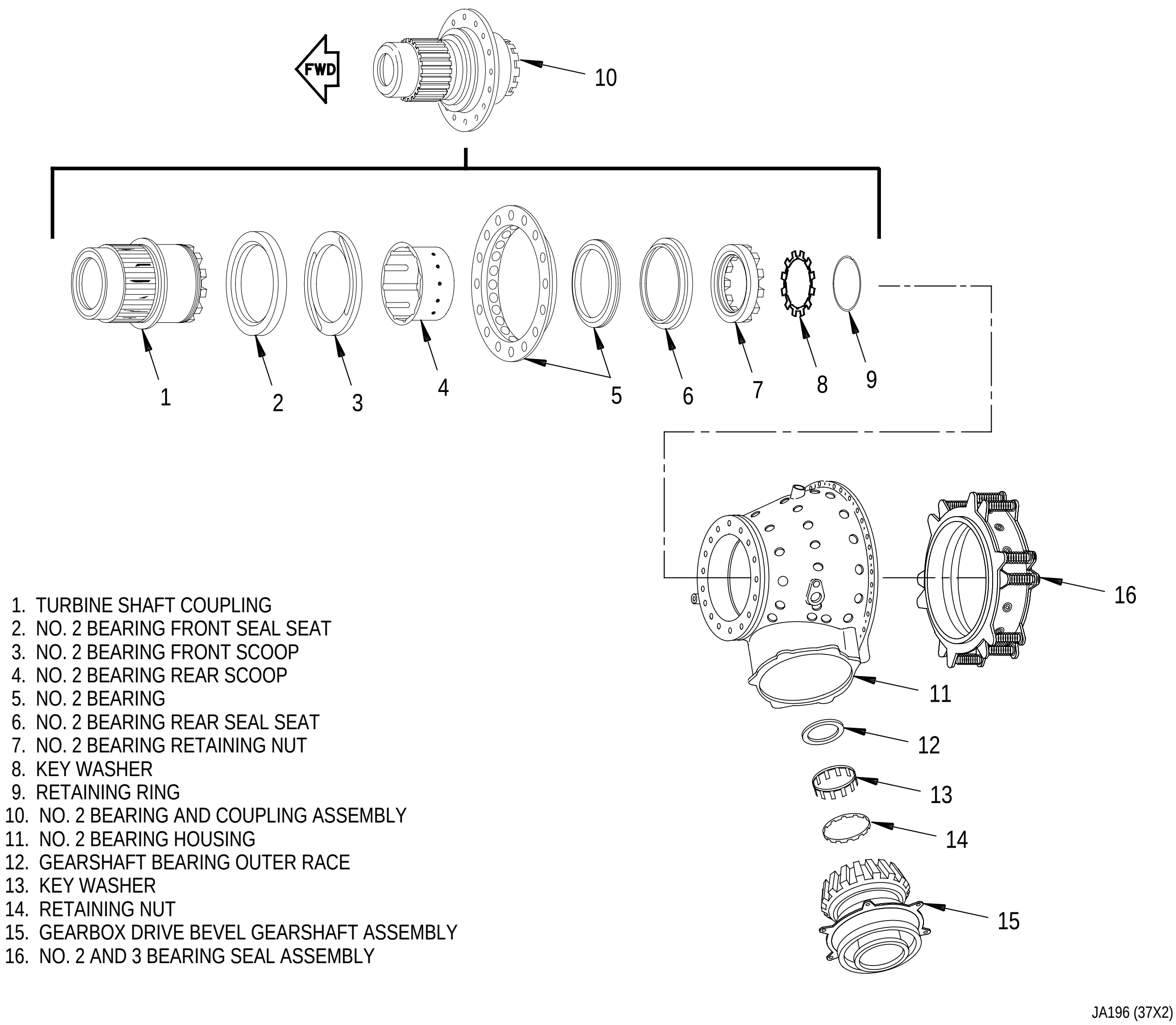


Figure 3. No. 2 Bearing and Coupling Assembly (Sheet 2 of 2)

f. The No. 2 bearing housing assembly contains the No. 2 bearing and coupling assembly. The housing assembly is supported by the No. 2 bearing support.

g. Both seal assemblies are carbon seals which are air and spring loaded. (See figure 4.)

h. The No. 2 bearing can be replaced at intermediate maintenance.

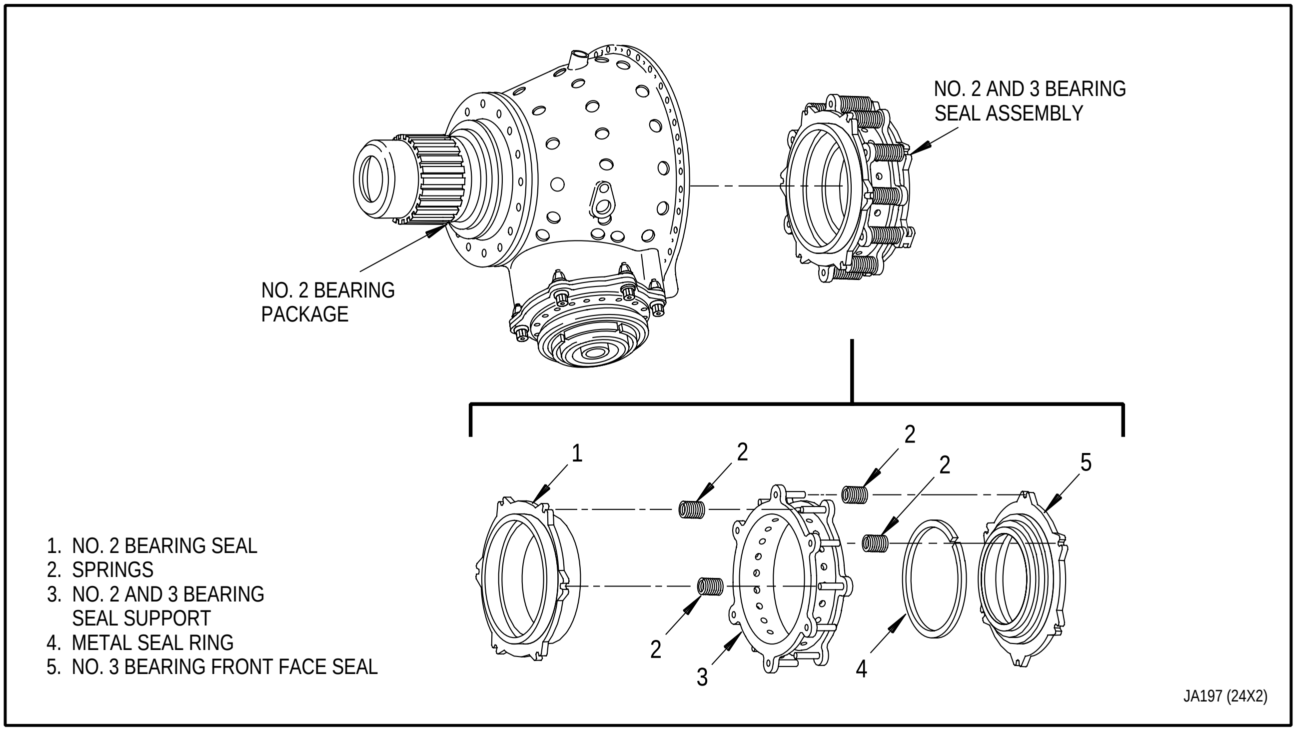


Figure 4. No. 2 and 3 Bearing Seal Assembly

5. No. 3 BEARING AND GEAR ASSEMBLY. (See figure 4 and Figures 5 and 6.)

a. Like the No. 2 bearing and coupling assembly, the No. 3 bearing and gear assembly (No. 3 bearing package) is housed in the compressor intermediate case. (See figure 5.)

b. The major components of the No. 3 bearing and gear assembly are:

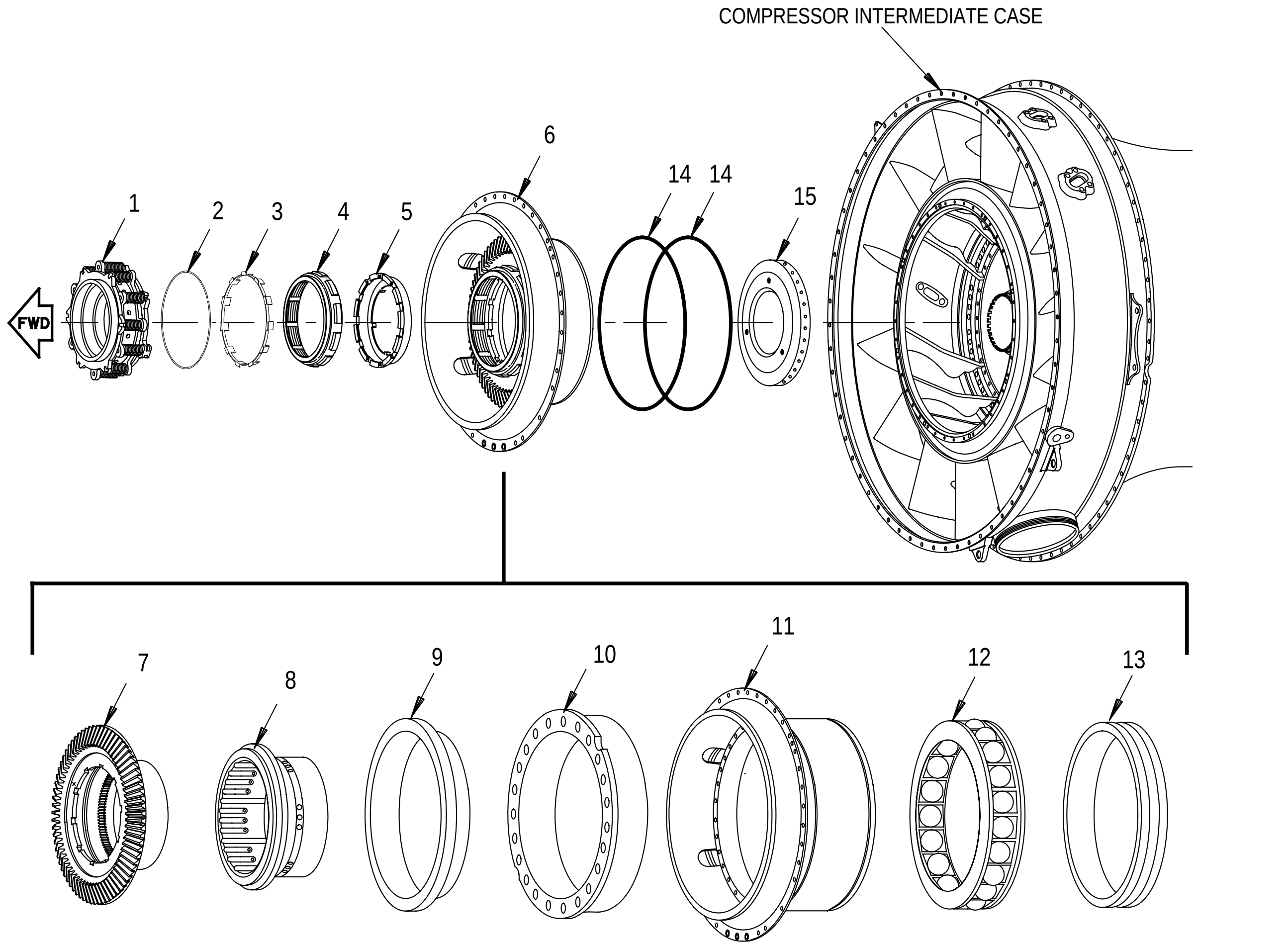
- No. 3 bearing support
- No. 3 bearing
- gearbox drive bevel gear
- No. 3 bearing rear seal assembly

c. The No. 3 bearing is a ball-type thrust bearing with:

- flange mounted outer race
- split inner races

(1) The No. 3 bearing supports the rear compressor front hub.

(2) The No. 3 bearing is attached to the gearbox drive bevel gear.



1. NO. 2 AND NO. 3 BEARING SEAL ASSEMBLY
2. RETAINING RING
3. KEY WASHER
4. RETAINING NUT
5. NO. 3 BEARING LOCK
6. NO. 3 BEARING AND GEAR ASSEMBLY (NO. 3 BEARING PACKAGE)
7. GEARBOX DRIVE BEVEL GEAR
8. NO. 3 BEARING REAR SCOOP
9. NO. 3 BEARING INNER RACE (FRONT HALF)
10. NO. 3 BEARING OUTER RACE
11. NO. 3 BEARING SUPPORT
12. NO. 3 BEARING CAGE AND BALLS
13. NO. 3 BEARING INNER RACE (REAR HALF)
14. PACKING
15. NO. 3 BEARING REAR SEAL SEAT

Figure 5. No. 3 Bearing and Gear Assembly

d. The gearbox drive bevel gear engages the gearbox drive bevel gearshaft (part of the No. 2 bearing package).

e. The No. 3 bearing support houses and supports the No. 3 bearing package.

f. The No. 3 bearing package is bordered, front and rear, by:

- No. 2 and 3 bearing seal assembly
- No. 3 bearing rear seal assembly

g. Both seal assemblies are carbon seals which are spring and air loaded. (See figures 4 and 6.)

h. The No. 3 bearing can be replaced at intermediate maintenance.

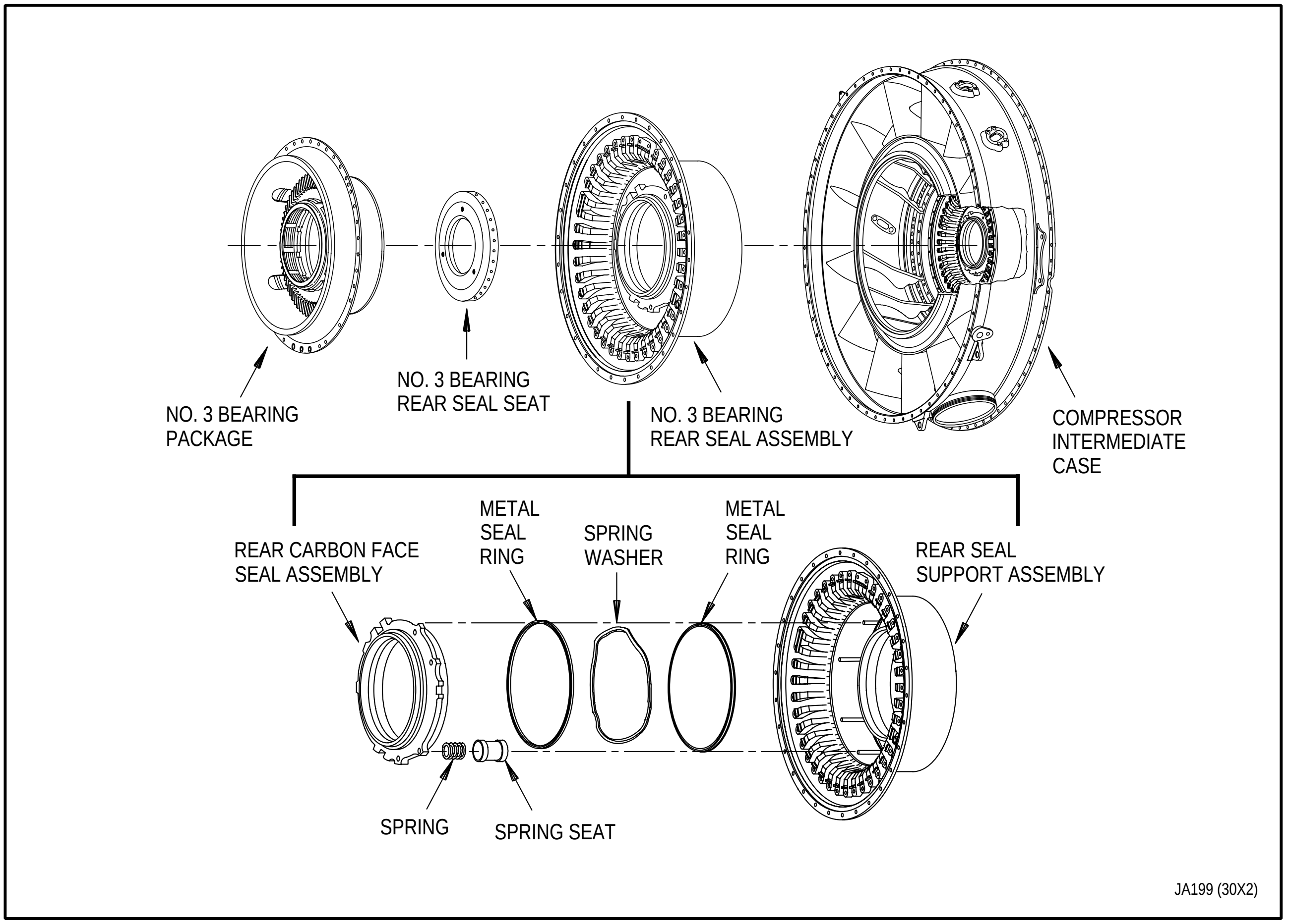


Figure 6. No. 3 Bearing Rear Seal Assembly

6. REAR COMPRESSOR INLET VARIABLE VANES.

a. The compressor intermediate case also contains the rear compressor inlet variable vanes.

b. These vanes guide and straighten the primary airflow from the compressor intermediate case struts as it passes into the rear compressor.

c. The position of the rear compressor inlet variable vanes is controlled by the rear compressor variable vane (RCVV) cylinders.

7. REAR COMPRESSOR ROTOR ASSEMBLY AND STATORS.
(See Figure 7.)

a. The rear compressor rotor assembly and stators is a 10 stage axial flow compressor.

(1) The IGVs, 4th, and 5th stage vanes are variable, positioned by the rear compressor variable vane (RCVV) cylinders.

NOTE

The 13th stage vanes are part of the compressor exit stator assembly located in the diffuser case.

(2) The 6th through 13th stage compressor stator vanes are fixed.

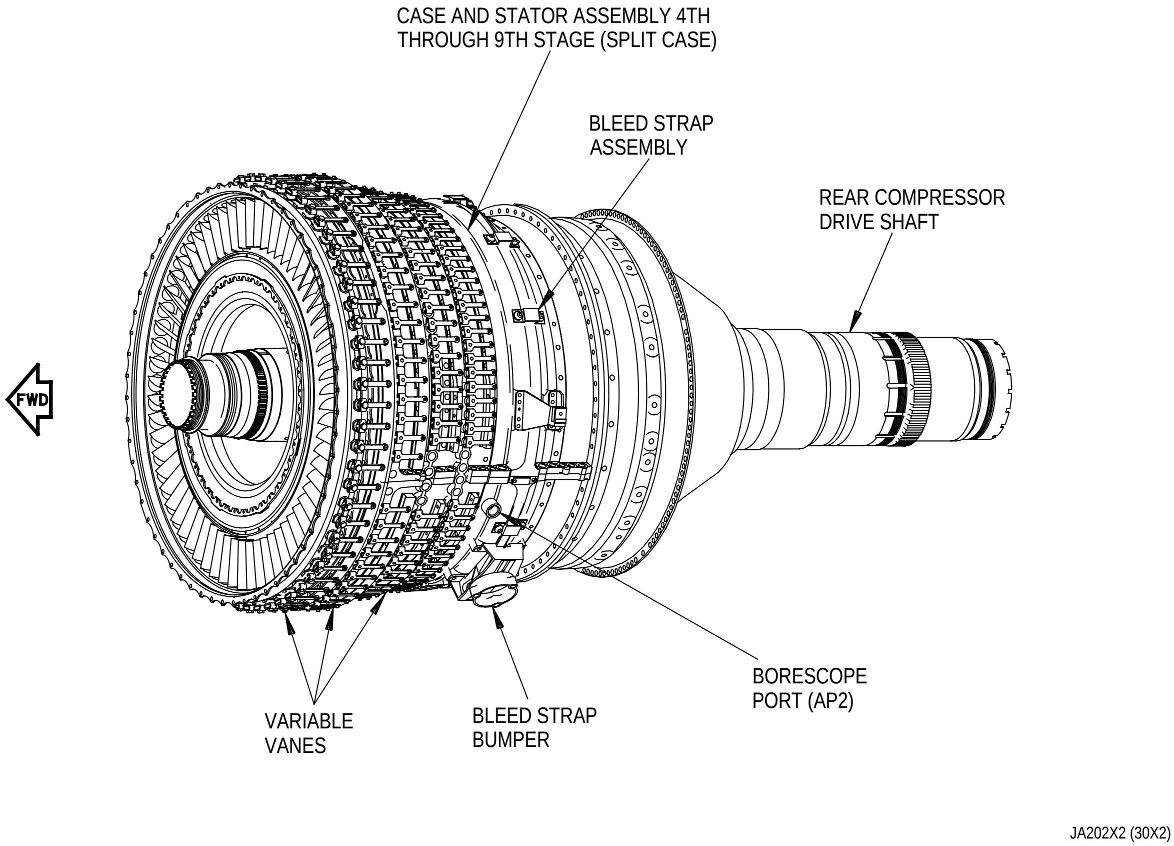


Figure 7. Rear Compressor Rotor and Stator Assembly

b. The seven stage drum rotor (stages 7 through 13) consists of a disk drum rotor and blades.

(1) The 6th stage rotor has a flat disk which is combined as a unit with the rear compressor front hub.

(2) The rear compressor drive shaft is part of the drum rotor.

(a) The rear compressor driveshaft connects the rear compressor rotor to the rear compressor drive turbine.

(b) The front compressor drive turbine shaft passes through the inside of the rear compressor driveshaft.

c. An interstage bleed strap, used to bleed air during engine start is located aft of the 7th stage stator.

(1) A bleed strap mechanism circles the 7th stage compressor case, covering the bleed air ports.

(2) A strap mechanism tightens or loosens the bleed strap on a signal from the main fuel control.

d. Borescope inspection ports are located between the 6th and 7th stages and the 12th and 13th stages.

e. Anti-icing air for the engine inlet and air for the aircraft environmental control system is taken from the 13th stage compressor.

8. FUEL NOZZLES AND LEFT AND RIGHT FUEL SUPPLY MANIFOLDS.
(See Figure 8.)

a. Twenty-four fuel nozzles, located in the diffuser case, deliver a fuel-air mixture, finely sprayed in regulated amounts to the engine combustion chamber.

(1) The fuel nozzle is a single tube with a metering valve to regulate fuel flow based on inlet pressure.

(2) There are two types of fuel nozzles: staged and unstaged.

(a) Nozzle staging enhances air-restart capability.

(b) The staged fuel nozzle metering valve is designed to provide increased local fuel/air ratio during the starting cycle. When ground idle speed is reached, staged nozzle flow becomes identical to unstaged nozzle flow. Staged nozzles are installed in the upper twelve positions on the diffuser case.

(c) Unstaged fuel nozzles are installed in the lower twelve positions on the diffuser case.

(d) Nozzle flange bolthole scheme is different between staged and unstaged nozzles which prevent mislocation of the two nozzles types.

(3) The nozzle operates on an air blast principle.

(a) As fuel passes out of the large opening in the nozzle, there is a slight pressure drop.

(b) Air is blasted through the center of the nozzle while swirl vanes reduce the fuel-air mixture to a fine spray.

b. Fuel nozzles incorporate a last chance strainer. This strainer protects the nozzle from contaminants large enough to damage the metering valve.

c. The left and right fuel supply manifolds circle the diffuser case at Flange T.

d. The manifolds supply fuel to each of the 24 fuel nozzles.

e. The fuel nozzles and fuel supply manifolds can be replaced at intermediate maintenance.

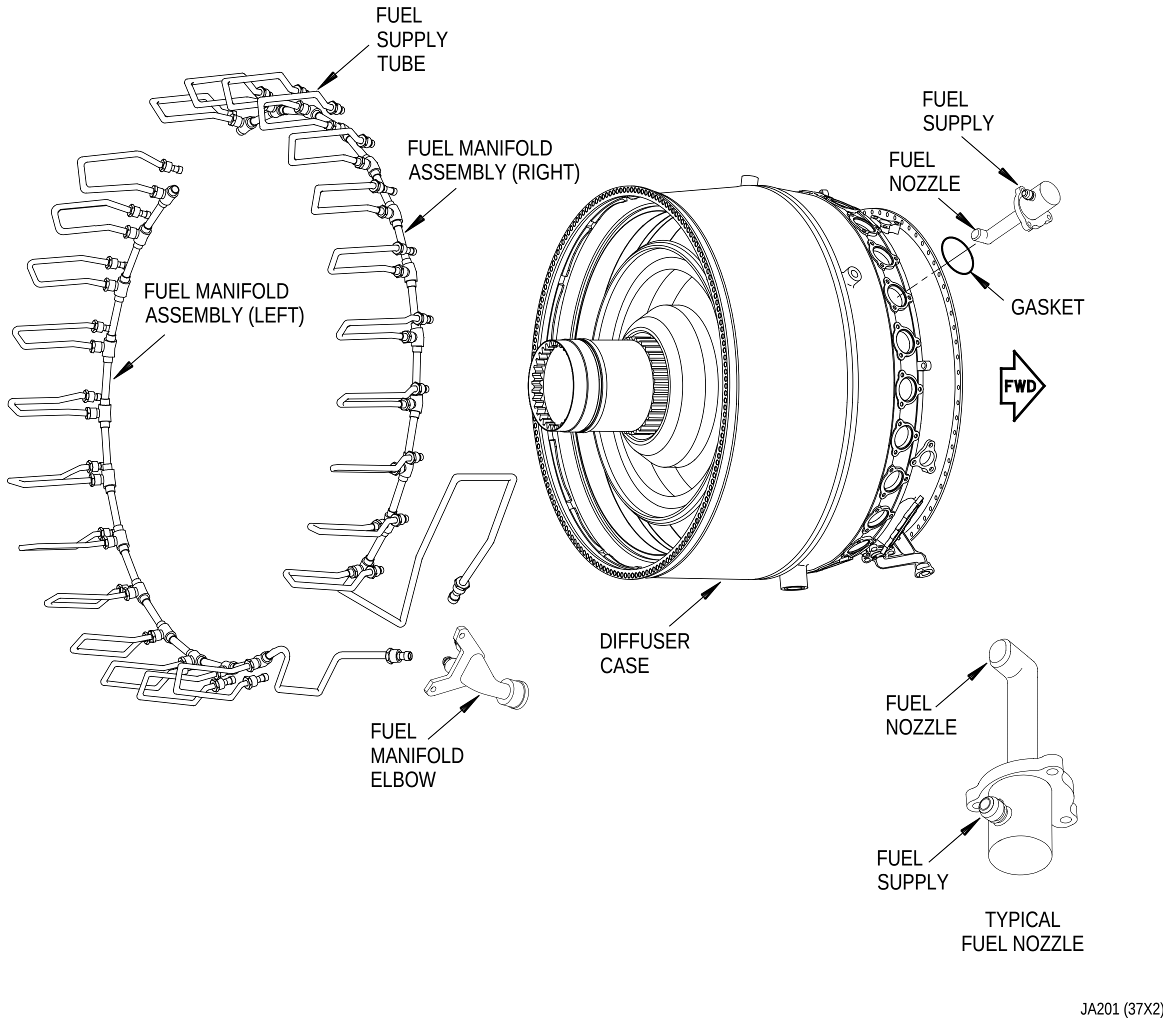


Figure 8. Fuel Nozzle and Left and Right Fuel Supply Manifold

9. DIFFUSER CASE.

(See Figure 9.)

a. The diffuser case contains:

- exit compressor stator assembly with 13th stage vanes
- eight hollow radial struts
- combustion chamber assembly
- No. 4 bearing

b. The exit compressor stator assembly is bolted to the forward end of the diffuser case.

(1) As air flows through the 13th stage stator vanes and enters the diffuser case:

- velocity decreases
- pressure increases

(2) Thirteenth stage air is bled through the diffuser case struts into the cabin air manifold through an annulus in the diffuser case.

(a) A 4 o’clock port in the manifold supplies air to the augmentor fuel pump.

(b) An 8 o’clock port in the manifold supplies air to the convergent exhaust nozzle control.

c. The eight hollow radial struts:

- are aerodynamically designed
- transmit loads from the No. 4 bearing to the diffuser case
- contain the No. 4 bearing oil supply tube (12 o’clock strut)
- contain the No. 4 bearing oil scavenge and breather tube (6 o’clock strut)
- vent air from the No. 4 bearing compartment

d. The diffuser case contains 28 ports.

(1) Two borescope ports at the 1 and 11 o’clock positions permit visual inspection of:

- fuel nozzles
- combustion chamber, floatwall panels, swirlers, etc.
- 1st stage turbine vanes
- leading edges of 1st stage turbine blades
- leading edges and concave surfaces of 2nd stage turbine vanes

(2) Two igniter ports are at the 4 and 8 o’clock positions.

(3) Twenty-four ports contain fuel nozzles.

e. The diffuser case can be replaced at intermediate maintenance.

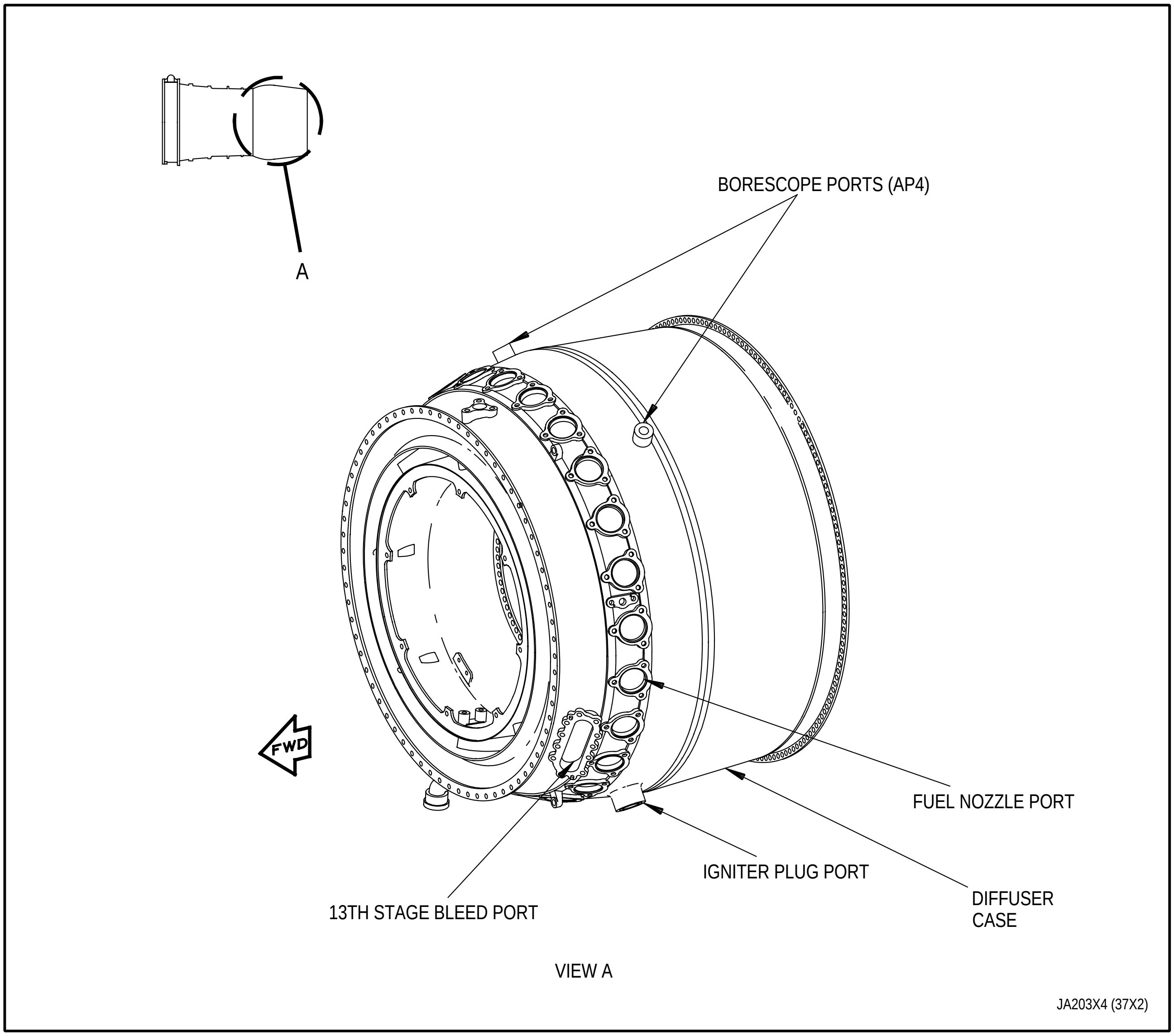


Figure 9. Diffuser Case

10. COMBUSTION CHAMBER ASSEMBLY.
(See Figures 10, 11, and 12.)

a. The combustion chamber assembly (combustor) has an annular ram induction design. (See figure 10.)

(1) As air becomes highly pressurized upon entering the diffuser case, it is forced through swirlers and into the combustion chamber assembly.

(2) A series of overlapping, louvered combustion chamber liner segments decrease the pressure loss so that there is no visible exhaust smoke. (See figure 11.)

(3) Guides direct a uniform airflow to swirler holes in the liner segments.

b. Two main spark igniters provide initial ignition of the fuel-air mixture in the combustion chamber. (See figure 12.)

(1) Although combustion is self-sustaining once started, ignition is continuous.

(2) The continuous igniter spark is automatically suppressed, however, by the increase in the combustor pressure as the engine accelerates.

(3) The main spark igniters are mounted externally through the fan ducts at the 4 and 8 o’clock positions.

(a) A spacer, available in incremental thicknesses (classified sizes), is placed between the main spark igniters and the diffuser case igniter bosses.

(b) The spacer ensures proper igniter immersion depth into the diffuser case and combustion chamber.

c. The combustion chamber is of FLOATWALL® panel design and is rear mounted to the 1st stage turbine stator support (TOBI). It contains five rows of removable liner segments. The liner segments are replaceable at intermediate maintenance.

d. The combustion chamber assembly can be replaced at intermediate maintenance.

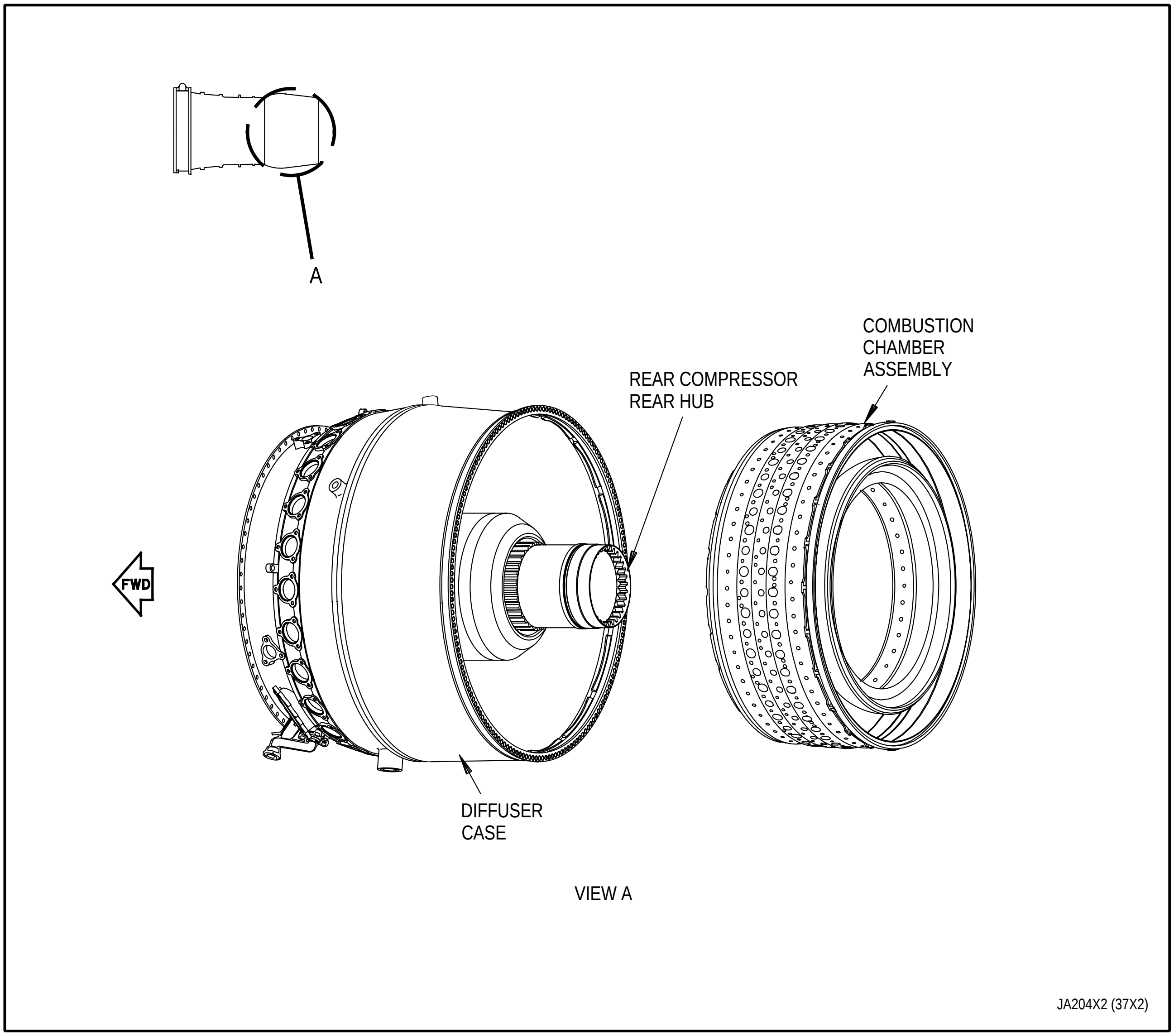


Figure 10. Combustion Chamber Assembly

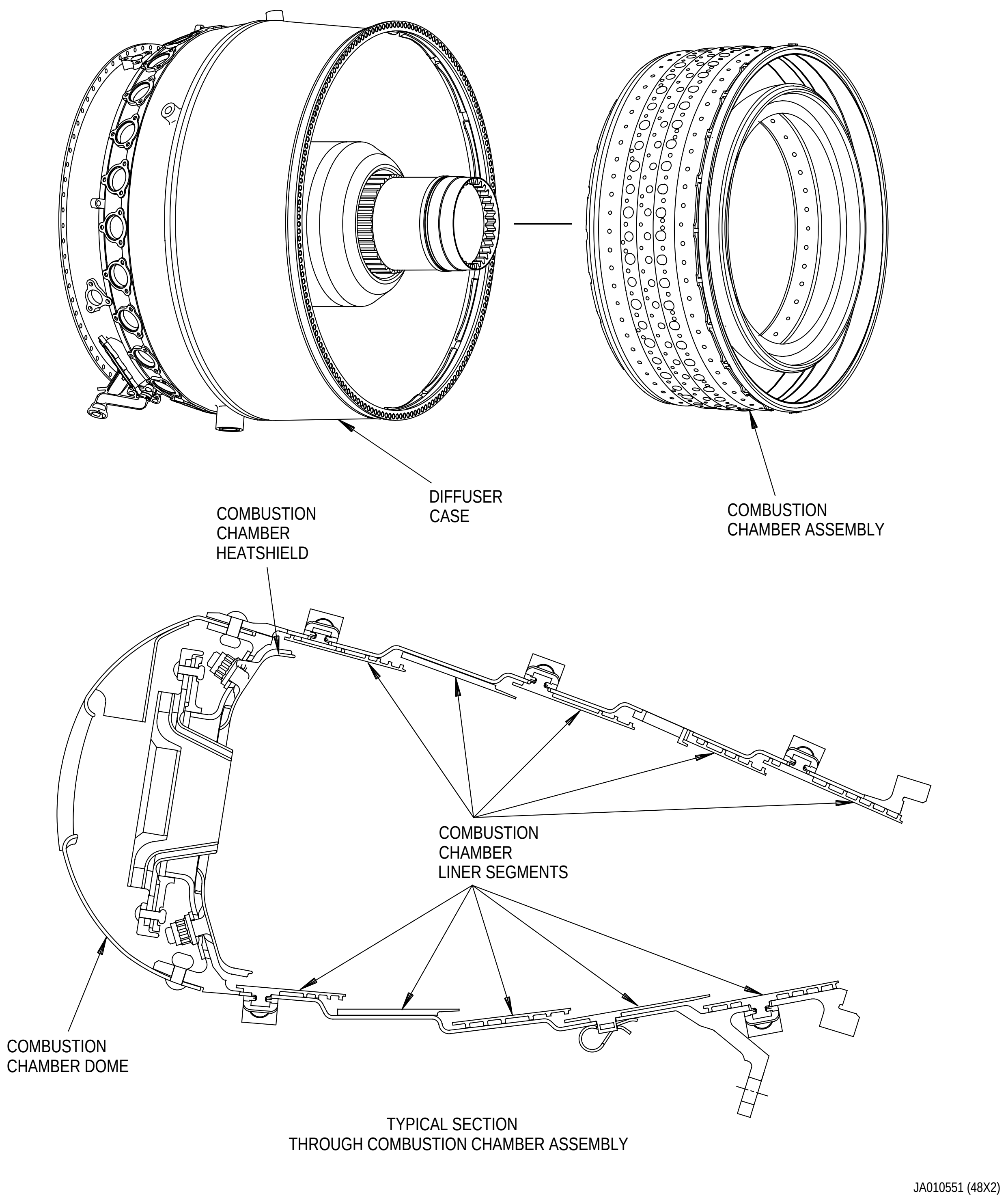


Figure 11. Combustion Chamber Assembly - Cross Section

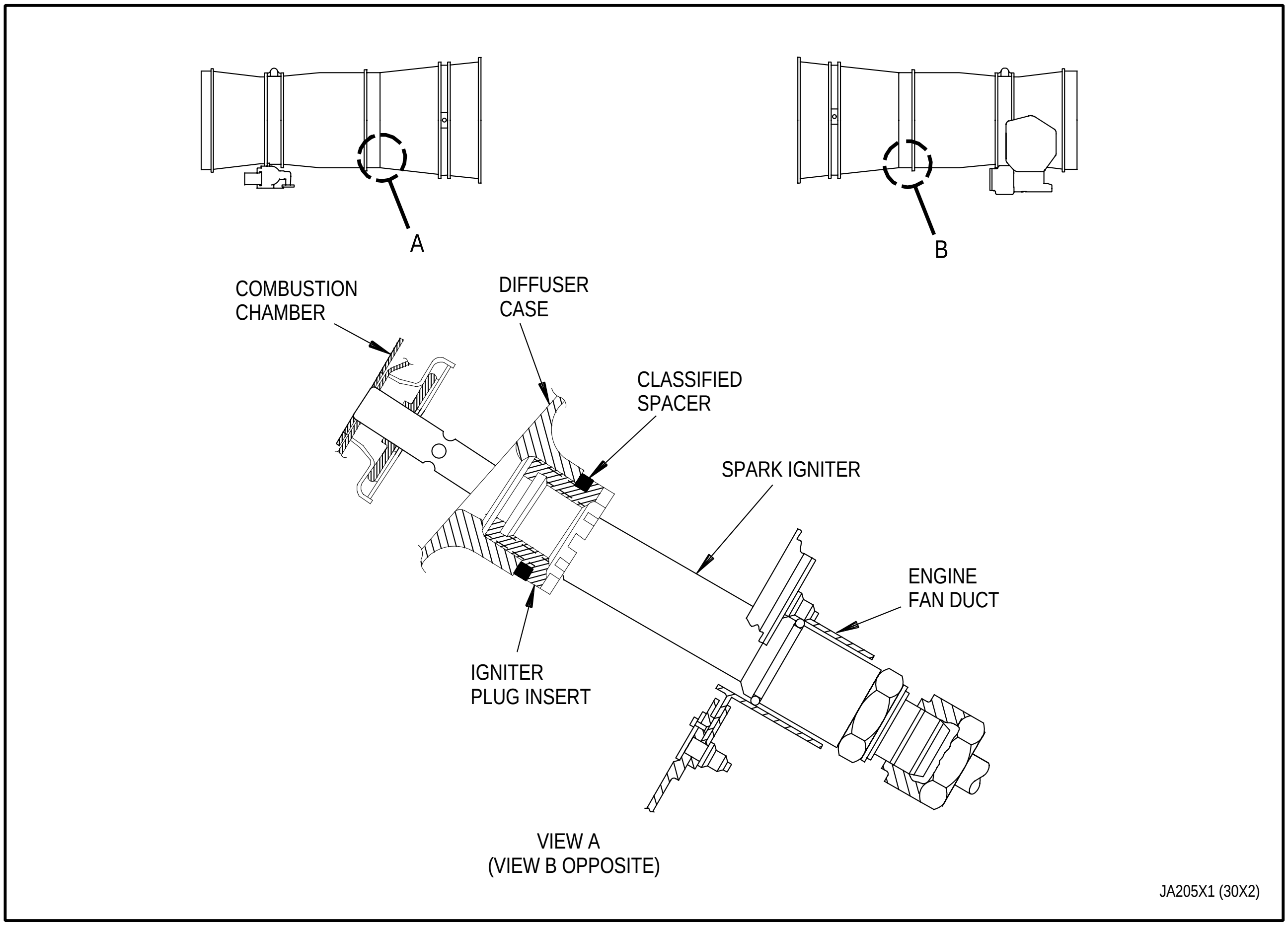


Figure 12. Combustion Chamber Igniter Plug

11. No. 4 BEARING.
(See Figures 13 and 14.)

a. The No. 4 bearing is located in the diffuser case aft of the combustion chamber.

b. The major components of the No. 4 bearing are:

- No. 4 bearing front and rear air sealing rings
- No. 4 bearing front air seal
- No. 4 bearing front and rear seal assemblies
- No. 4 bearing housing and outer race
- No. 4 bearing inner race and rollers

c. The No. 4 bearing is a roller-type bearing with an elliptical outer race. (See figure 13.)

(1) The outer race is attached to the No. 4 bearing housing.

(2) The inner race is on the rear compressor rear hub.

(3) The No. 4 bearing supports the rear compressor rear hub.

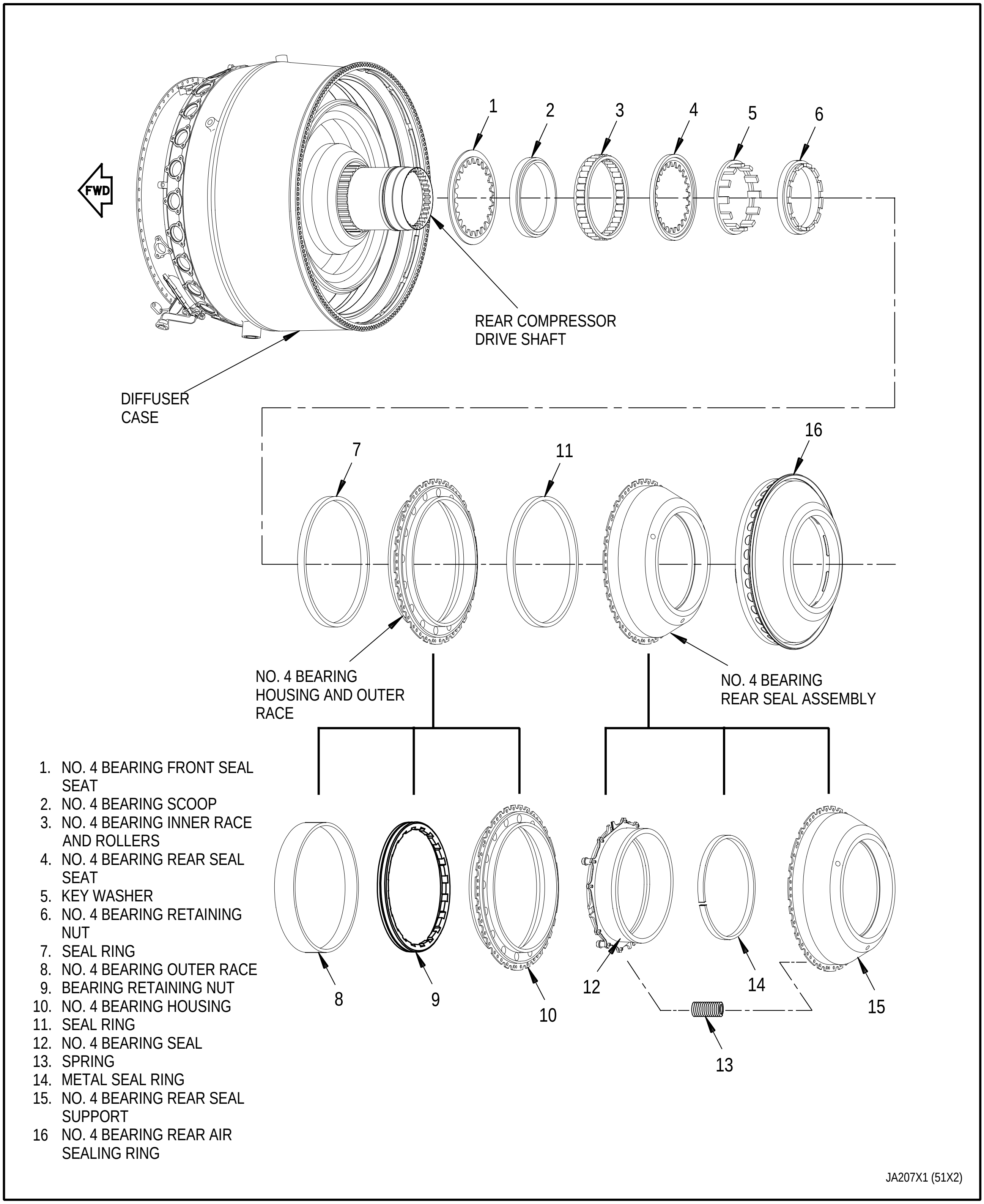


Figure 13. No. 4 Bearing and Rear Seals

d. The No. 4 bearing front air seal rides on the No. 4 bearing front air sealing ring. (See figure 14.)

(1) The front air seal has a series of knife-edges which form labyrinth-like compartments with the air sealing rings.

(2) These compartments allow 13th stage air to travel farther into the diffuser case.

e. The No. 4 bearing front and rear seal assemblies are springloaded face-type carbon seals.

f. The No. 4 bearing can be replaced at intermediate maintenance.

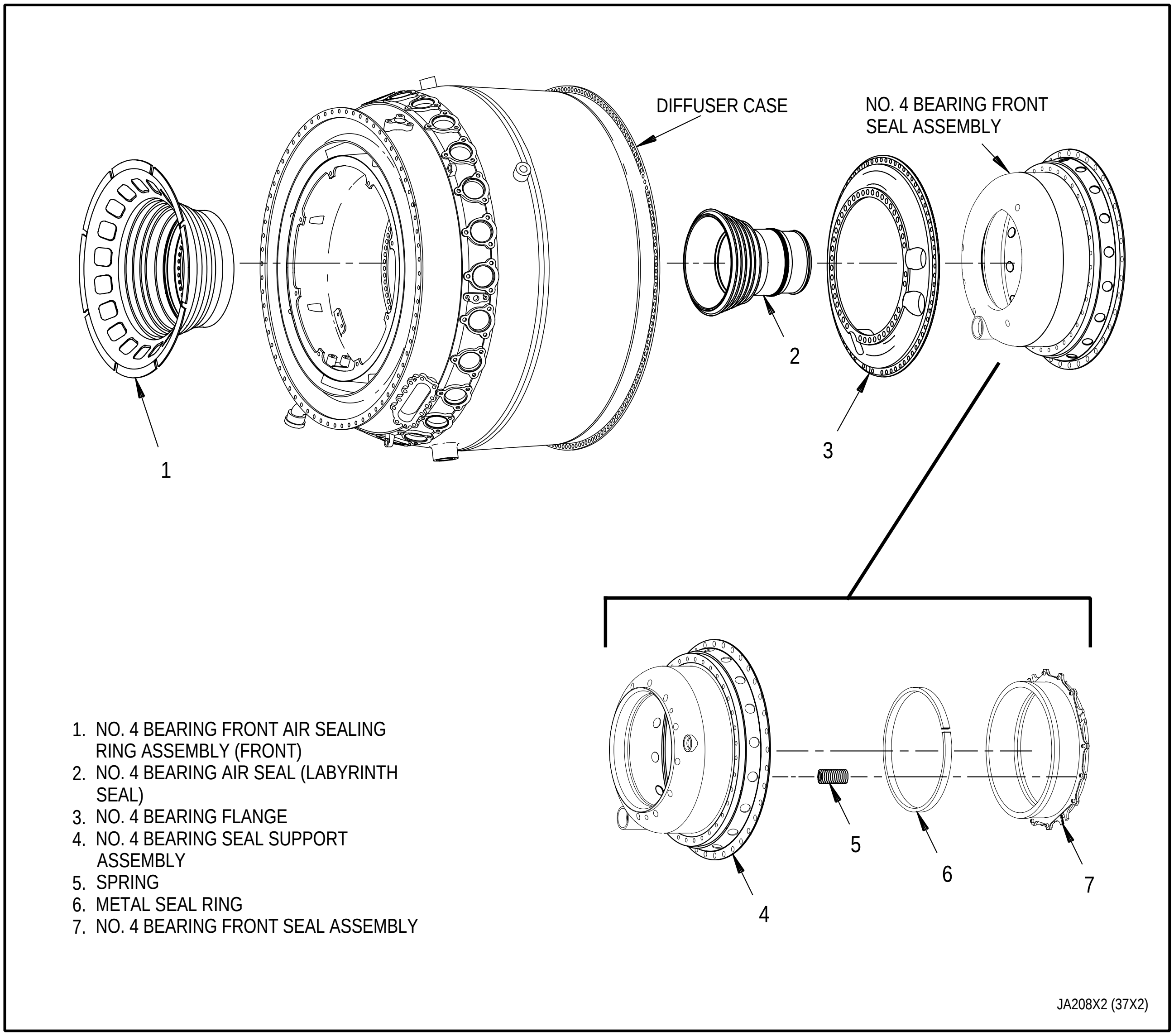


Figure 14. No. 4 Bearing Front Seal Assembly

12. REAR COMPRESSOR DRIVE TURBINE ROTOR AND STATOR ASSEMBLY.

(See Figure 15.)

a. The rear compressor drive turbine includes:

- 1st stage turbine disk and turbine rotor blade assemblies
- 2nd stage turbine disk, hub assembly and 2nd stage turbine rotor blade assembly
- 2nd stage turbine stator vane assemblies
- 1st stage turbine and duct and support set

b. The two turbine rotor stages are contained in the diffuser case.

(1) The 1st stage turbine disk is secured to the hub and 2nd stage disk with tie rods.

(2) Turbine rotor blades for both stages:

- are cooled by 13th stage air
- are moment-weighted
- have fir-tree roots
- are secured to disks by blade retainers

(3) First and second stage blades can be replaced without rebalancing the rotors.

NOTE

The rear compressor driveshaft nut, lock, and retaining ring, the 1st stage turbine stator support assemblies, and the 1st stage turbine stator vanes are details of the core module, not the rear compressor drive turbine.

c. The hub is splined to the rear compressor driveshaft which connects the rear compressor drive turbine to the rear compressor rotor and stator assembly. The rear compressor driveshaft nut retains the hub on the driveshaft.

d. The 1st stage turbine stator vane assembly is contained by two support assemblies.

e. The 2nd stage turbine stator vane assembly is attached to the 2nd stage turbine air sealing ring on the ID and the second vane OD support on the OD.

f. The 1st stage turbine and support duct set:

- contains two turbine rotor stages
- contains 2nd stage turbine stator vanes with duct

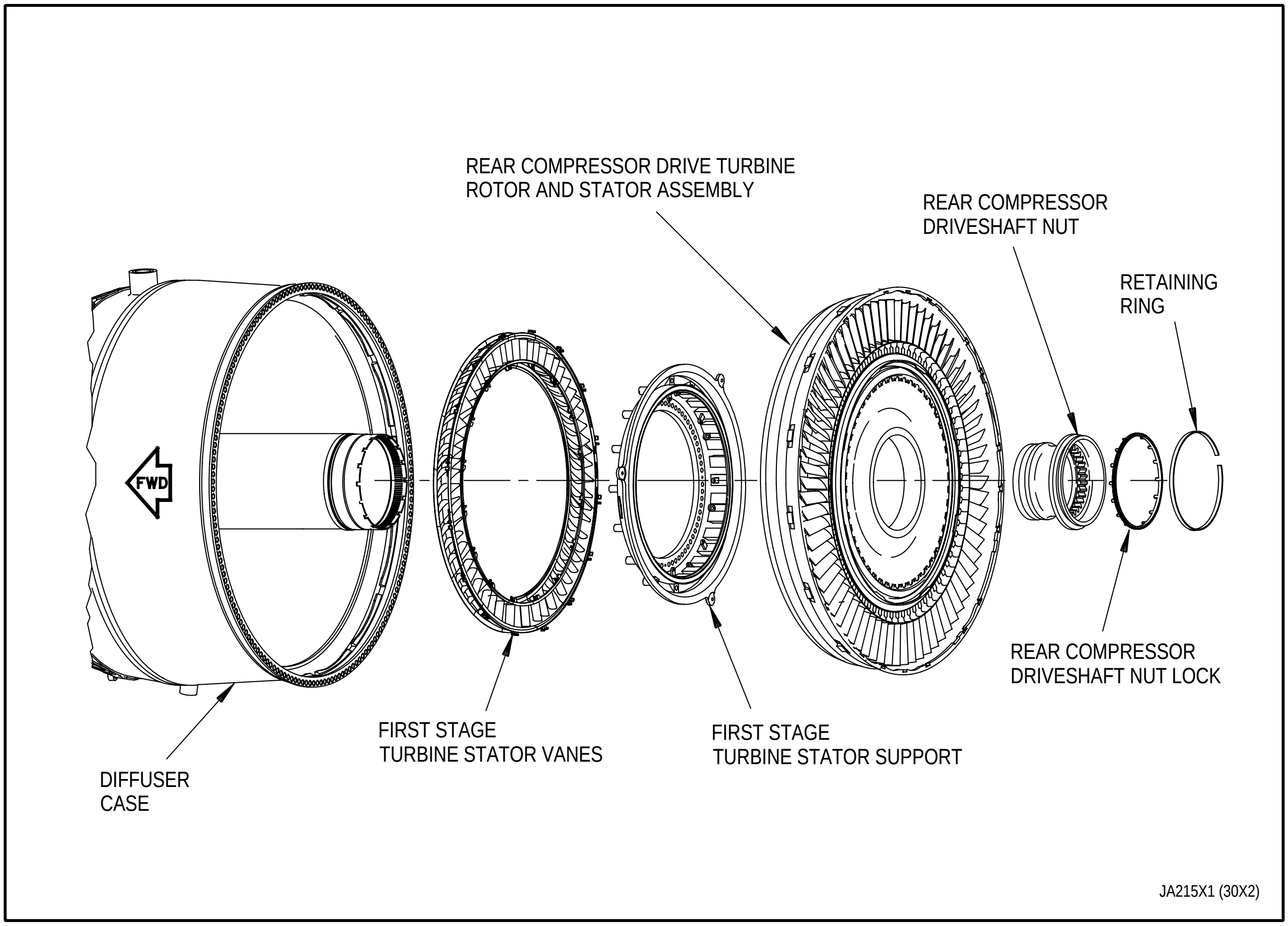


Figure 15. Rear Compressor Drive Turbine Rotor and Stator Assembly (Sheet 1 of 2)

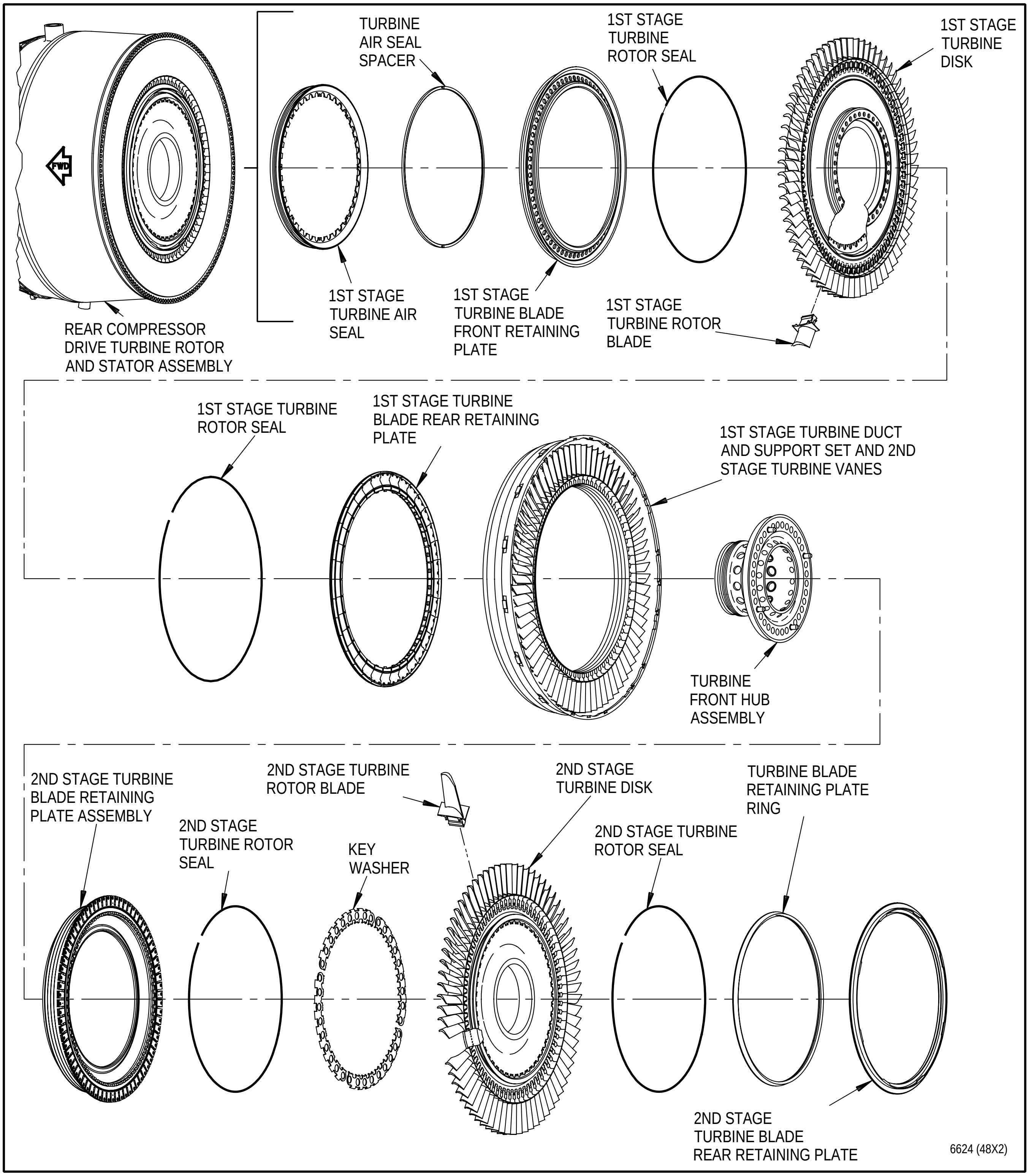


Figure 15. Rear Compressor Drive Turbine Rotor and Stator Assembly (Sheet 2 of 2)

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - FAN DRIVE TURBINE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 12

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains a description of the fan drive turbine module and its major parts.

2. FAN DRIVE TURBINE MODULE.

(See Figure 1.)

a. The fan drive turbine module consists of:

- front compressor drive turbine rotor and stator assembly
- front compressor drive turbine shaft
- rear turbine case and duct set
- turbine exhaust case
- No. 5 bearing

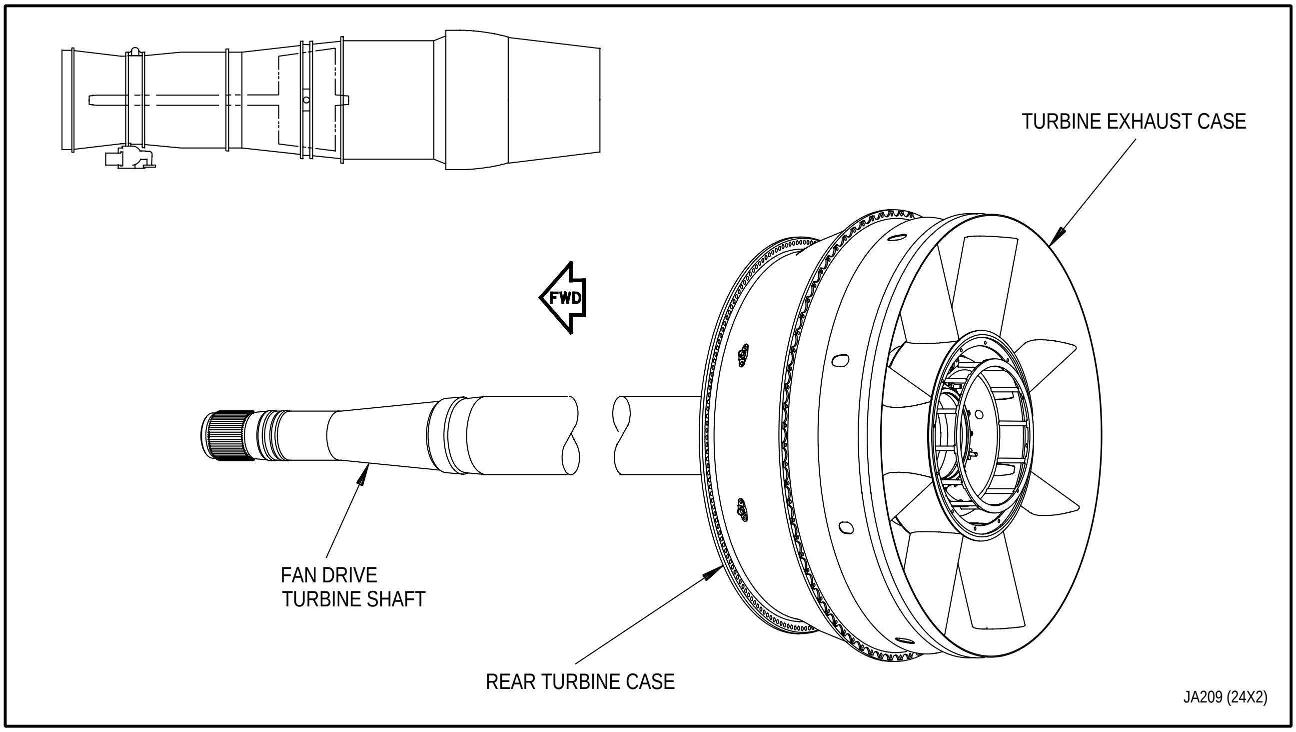


Figure 1. Fan Drive Turbine Module

3. FRONT COMPRESSOR DRIVE TURBINE ROTOR AND STATOR ASSEMBLY.
(See Figure 2.)

a. The front compressor drive turbine consists of:

- 3rd and 4th stage turbine disk and blade assemblies
- 3rd and 4th stage turbine stator vane assemblies
- rear turbine hub assembly

b. The 3rd and 4th disk are a damage-tolerant, no-hole design which reduce stress concentrations. The disks are joined to the turbine hub assembly by tierods.

c. The 3rd and 4th stage turbine blades:

- are not air-cooled
- are moment-weighted
- have tip shrouds

d. These turbine blades also have knife-edge tips which are designed to ride against honeycombed rubstrips on the ID of the 3rd and 4th stage air sealing ring segments.

e. The 3rd and 4th stage turbine stator vanes:

- are contained in the rear turbine case
- are not air cooled
- are attached to the 3rd and 4th stage air sealing rings at the ID and to the turbine case at the OD lugs.

f. The front compressor drive turbine rotor and stator assembly can be replaced at intermediate maintenance.

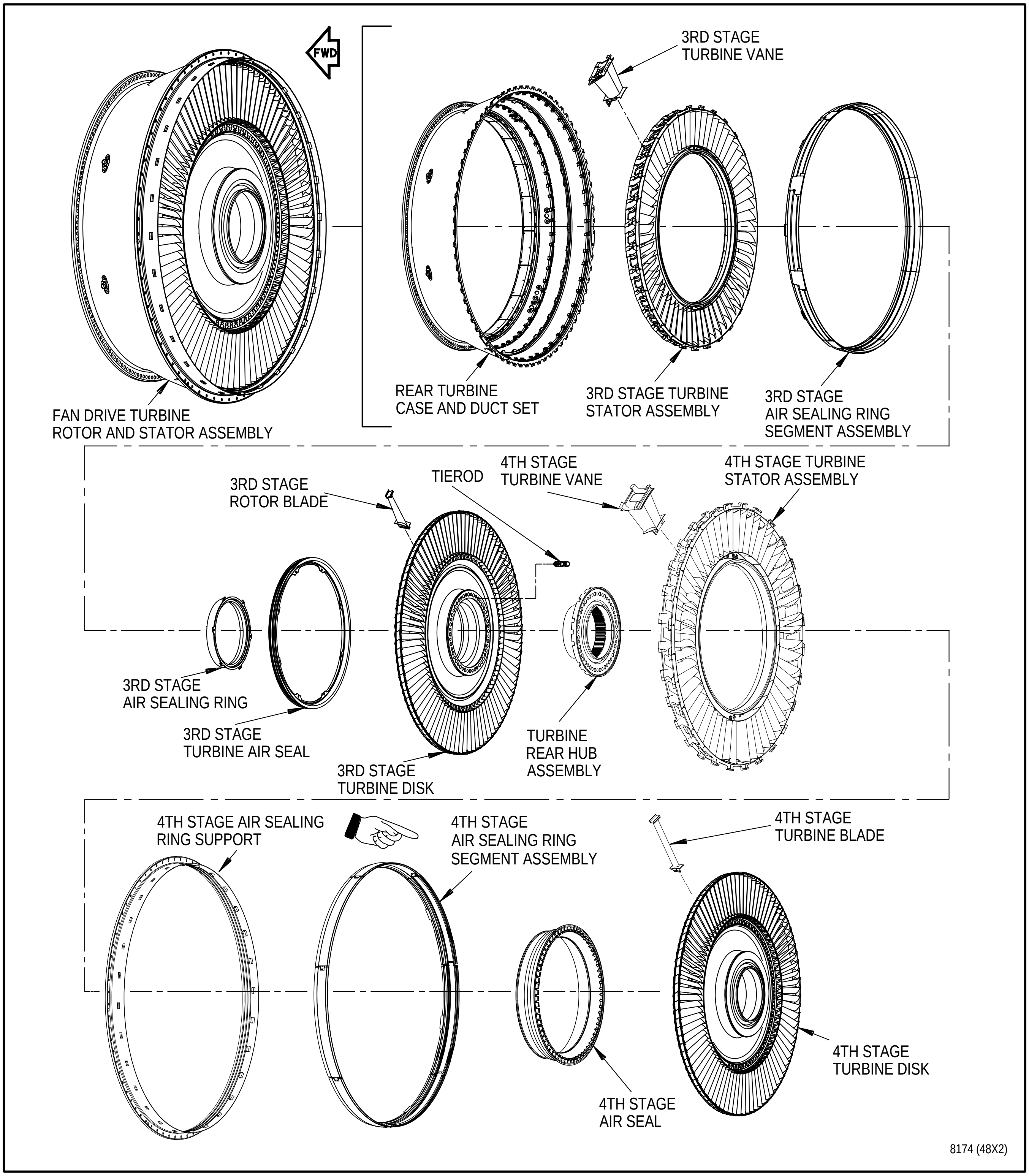


Figure 2. Front Compressor Drive Turbine Rotor and Stator Assembly and Rear Turbine Case and Duct Set

4. FRONT COMPRESSOR DRIVE TURBINE SHAFT.
(See Figure 3.)

a. The front compressor drive turbine shaft connects the front compressor drive turbine to the front compressor rotor and stator assembly in the inlet fan module.

(1) The aft end of the shaft contains the No. 5 bearing and engages the No. 5 bearing retaining nut and the rear turbine hub assembly.

(2) The shaft passes through the rear compressor driveshaft and is connected to the front compressor by the turbine shaft coupling (part of the No. 2 bearing package).

b. The shaft is supported by the No. 2 bearing and coupling assembly and the No. 5 bearing.

5. REAR TURBINE CASE AND DUCT SET.
(See figure 2.)

a. The rear turbine case and duct set is a combination of:

- rear turbine case
- 2nd stage turbine duct support
- 2nd stage turbine duct segment assembly

b. The rear turbine case contains:

- 3rd and 4th stage turbine stator vanes
- honeycombed 3rd and 4th stage turbine air sealing ring segment assemblies
- borescope inspection port at 5 o’clock position

c. The rear turbine case and duct set can be replaced at intermediate maintenance.

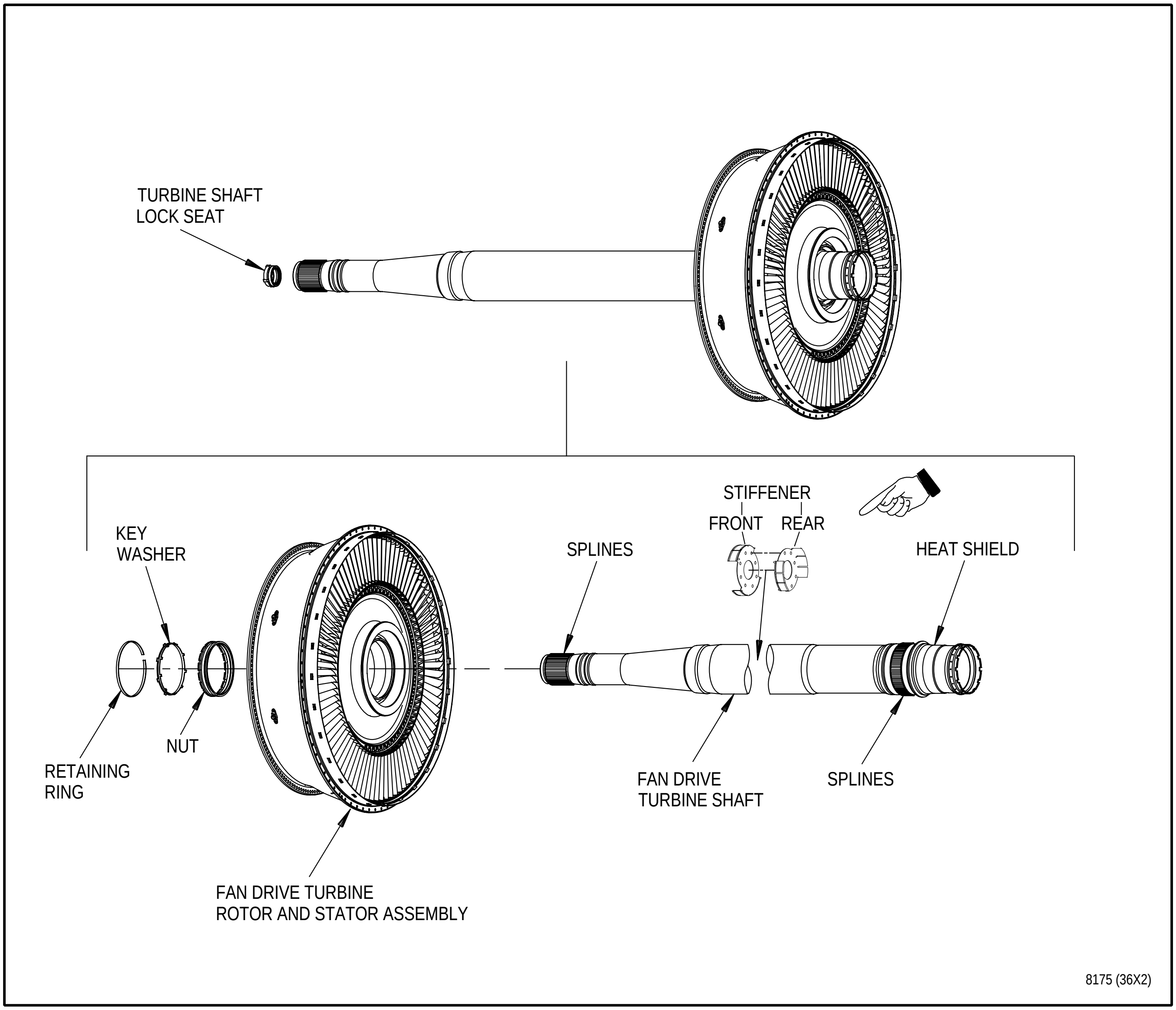


Figure 3. Front Compressor Drive Turbine Shaft

6. TURBINE EXHAUST CASE.
(See Figure 4.)

a. The turbine exhaust case is located aft of the rear turbine case.

b. The case contains:

- eight hollow radial struts
- No. 5 bearing seal support

c. The turbine exhaust case transmits the No. 5 bearing loads through its eight hollow radial struts.

(1) Four of these struts contain No. 5 bearing support rods.

(2) The support rods tie the No. 5 bearing seal support to the engine aft mount ring.

(3) The remaining struts contain the No. 5 bearing pressure and scavenge tubes.

d. The No. 5 bearing seal support is attached to the turbine exhaust case and houses the No. 5 bearing carbon seals.

e. The turbine exhaust case can be replaced at intermediate maintenance.

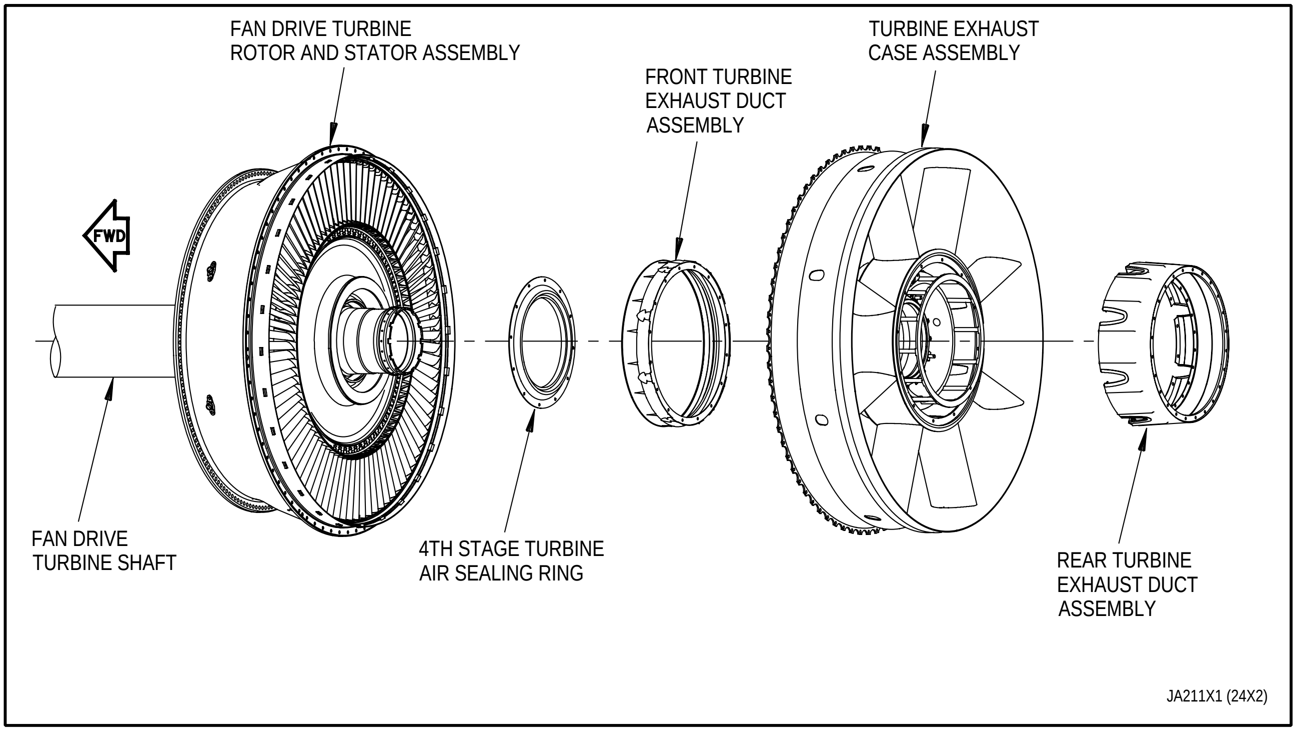


Figure 4. Turbine Exhaust Case

7. NO. 5 BEARING.

(See Figure 5.)

a. The No. 5 bearing is located inside the aft end of the front compressor drive turbine shaft.

b. The major components of the No. 5 bearing are:

- No. 5 bearing inner and outer supports
- No. 5 bearing outer race
- No. 5 bearing inner race and rollers
- No. 5 bearing rear seal assembly

c. The No. 5 bearing is a roller-type bearing with an elliptical outer race. (See figure 5.)

(1) The OD of the outer race rides on the ID of the front compressor drive turbine shaft.

(2) The inner race and rollers ride on the No. 5 bearing inner support.

(3) The outer support attaches to the aft end of the inner support.

d. No. 5 bearing rear seal assembly is:

- contained in the No. 5 bearing seal support
- a series of spring-loaded face-type carbon seals. (See figure 5.)

e. The No. 5 bearing and its supports can be replaced at intermediate maintenance.

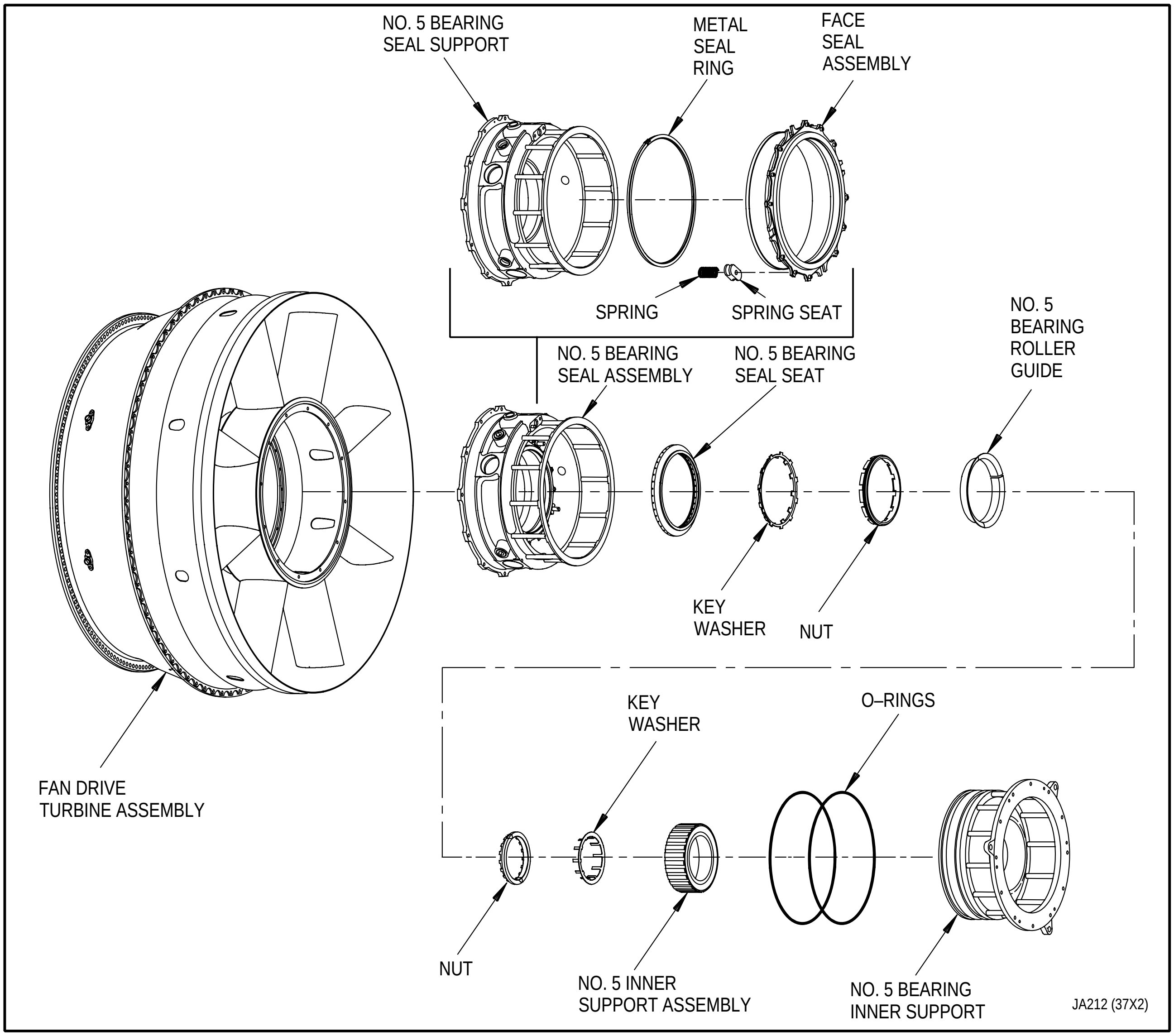


Figure 5. No. 5 Bearing

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

AUGMENTOR DUCT AND NOZZLE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 16

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 15	0				
16 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains a description of the augmentor duct and nozzle module and its major parts.

b. Because the turbine exhaust cone, rear fan duct, augmentor segment (spray) manifold assemblies, and augmentor flameholder assembly work in conjunction with the augmentor duct and nozzle module, a description of these nonmodular parts is also included in this work package.

2. AUGMENTOR DUCT AND NOZZLE MODULE. (See Figure 1.)

a. The augmentor duct and nozzle module provides increased thrust when required.

b. The augmentor duct and nozzle module consists of:

- augmentor combustion chamber duct
- augmentor combustion chamber liner segments
- augmentor nozzle actuators
- augmentor nozzle assembly

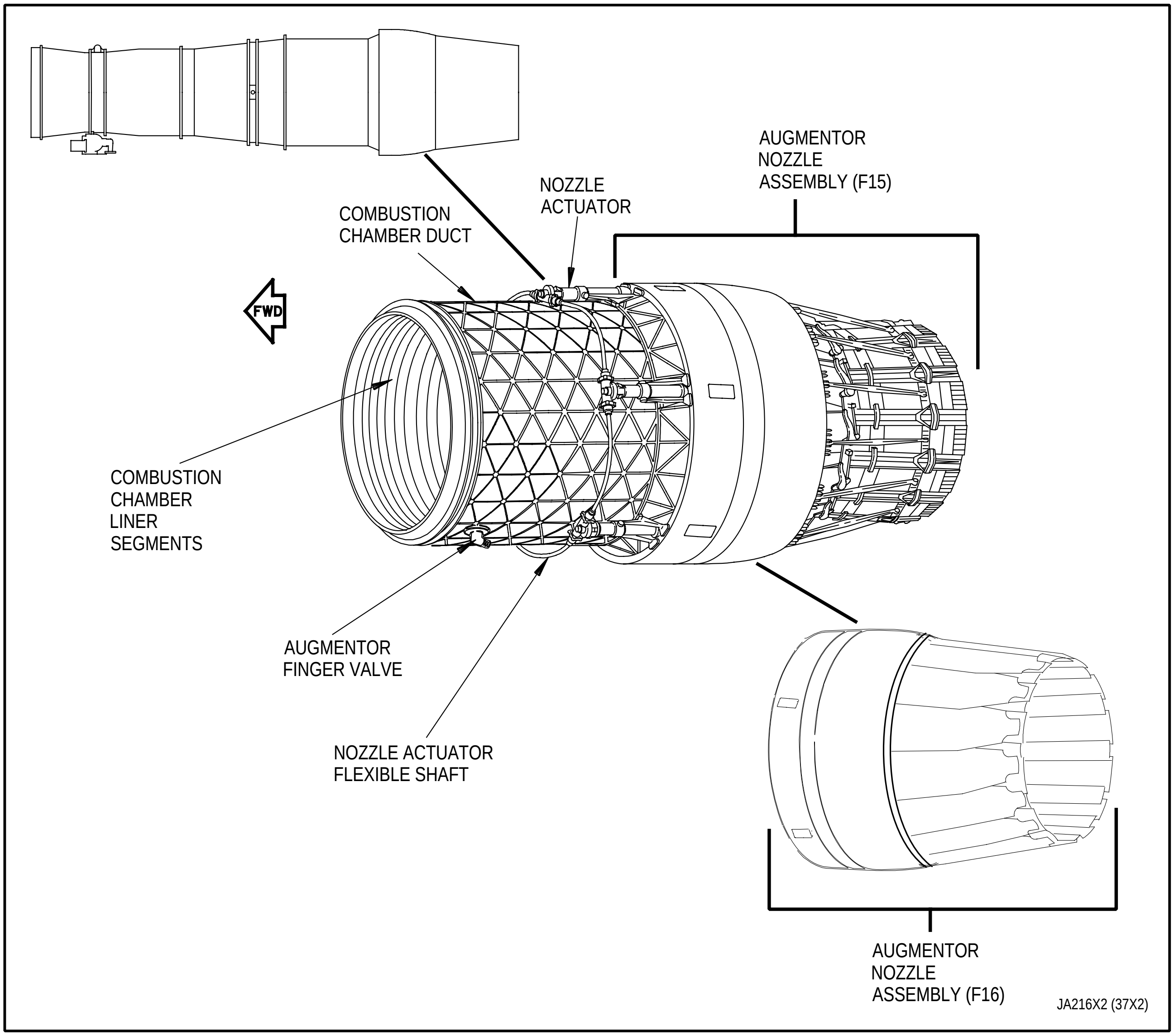


Figure 1. Augmentor Duct and Nozzle Module

c. Working in conjunction with the augmentor to produce increased thrust are:

- turbine exhaust cone
- rear fan duct
- augmentor segment manifold assemblies
- augmentor flameholder assembly

3. TURBINE EXHAUST CONE AND FAN REAR DUCT.

a. The turbine exhaust tail cone and the aft portion of the rear fan duct form a diffuser section.

b. This diffuser section mixes:

- hot turbine exhaust gases funneled through the turbine exhaust case and around the tail cone
- cooler fan inlet air funneled along the outer ducts to the rear fan duct and the augmentor duct

c. This diffuser section also reduces the velocity of the exhaust gas flow and the fan air flow.

d. By mixing the two streams and reducing their velocities, this diffuser section ensures proper engine performance in both the augmented and nonaugmented modes.

4. AUGMENTOR SEGMENT MANIFOLD ASSEMBLIES.

(See Figure 2.)

a. The augmentor segment manifold assemblies are mounted in the rear fan duct.

b. The segment manifold assemblies are a series of seven pressure sensitive fuel sprayrings arranged in 11 segments.

(1) Four dual-segment sprayrings (total eight segments).

(2) Three single-segment sprayrings (total three segments).

c. During augmentation the augmentor fuel control supplies a regulated fuel flow and fuel pressure to one or more of the sprayrings.

d. The spray rings incorporate fixed orifice discharge holes and a single feed line to all eleven segments. The small volume multiple spray rings allow for rapid transients to avoid blowouts and stalls.

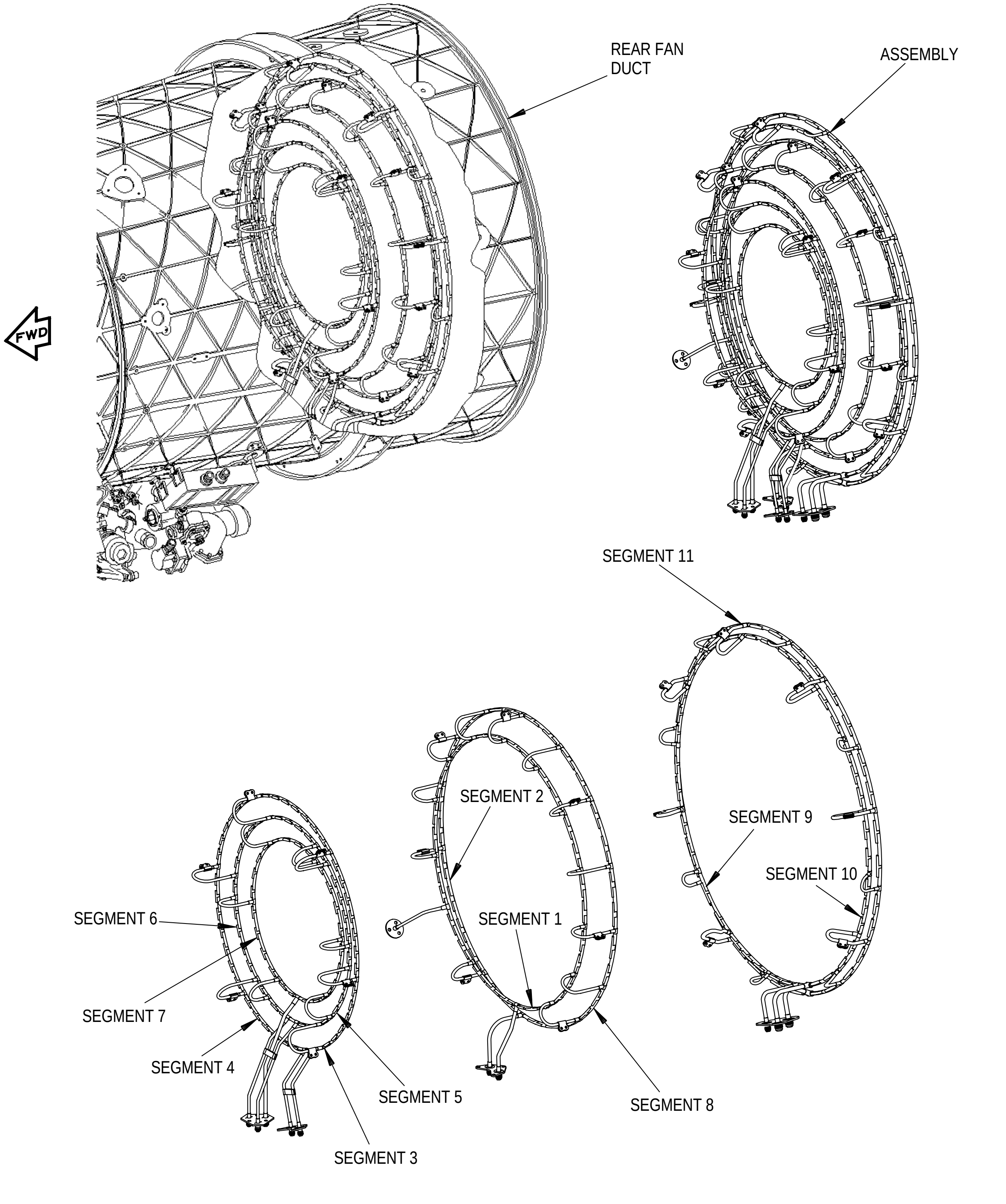


Figure 2. Augmentor Segment Manifold Assembly

5. AUGMENTOR FLAMEHOLDER ASSEMBLY. (See Figure 3.)

a. The augmentor flameholder assembly is mounted aft of the segment manifolds at the inlet to the augmentor combustion chamber liner.

b. The flameholder is a pilot ring in the form of a channel.

(1) Fuel spray from the first sprayring segment is directed through the open end channel to the pilot burner ring.

(2) Fuel is ignited by dual spark igniters which produce a pilot flame.

(3) Flame spreads around the pilot burner ring and into the radial flameholders.

(4) The radial flameholders branch inward toward the hot engine exhaust gas and outward toward the cooler fan air.

c. The flameholder also acts to reduce the velocity of the gases so that flame stability is maintained during augmentation.

d. Under nonaugmented conditions, the flameholder continues to mix the hot gases and the cooler fan air for a smoother performance in this mode.

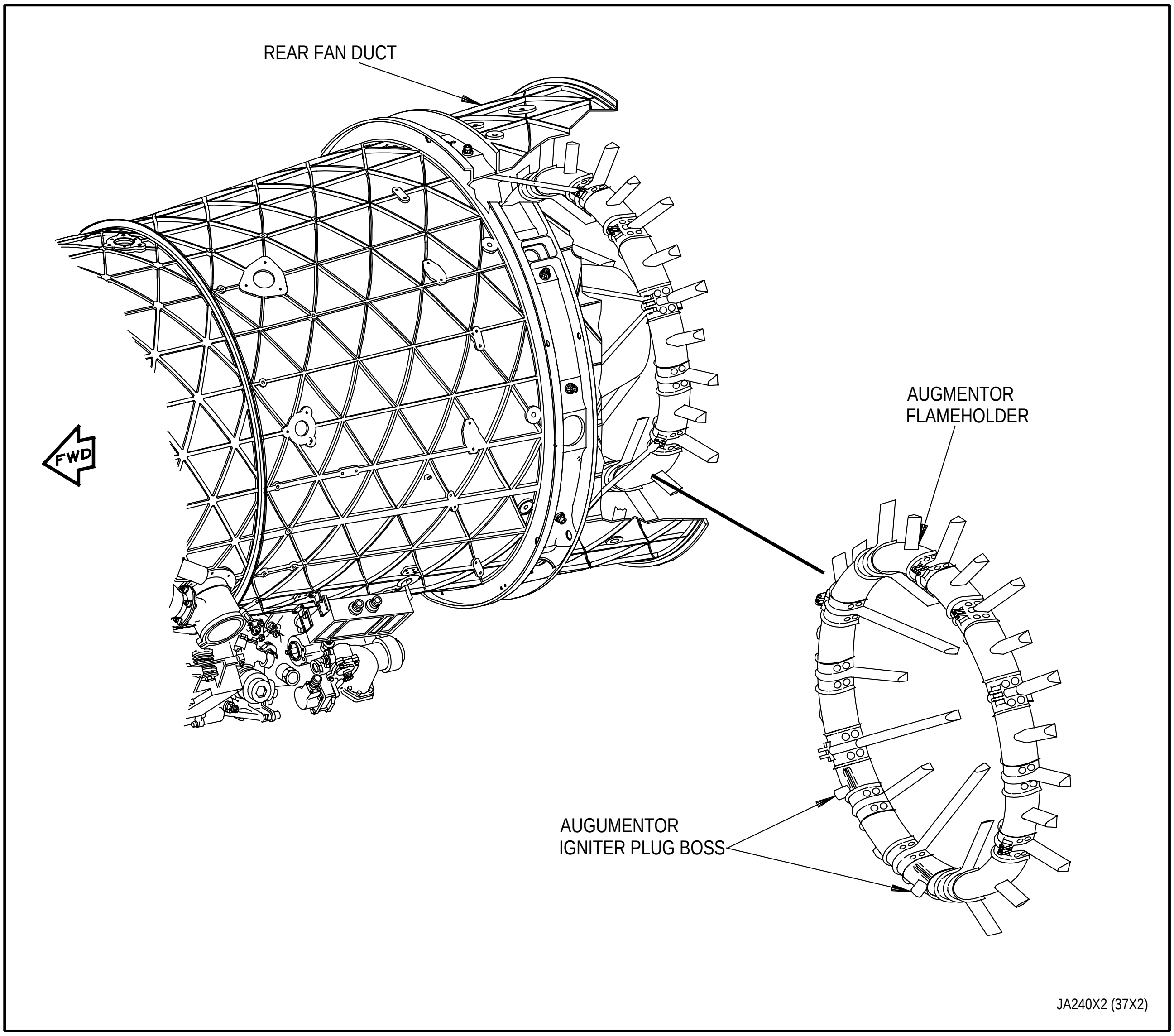


Figure 3. Augmentor Flameholder Assembly

6. AUGMENTOR COMBUSTION CHAMBER DUCT AND AUGMENTOR COMBUSTION CHAMBER LINER SEGMENTS.

(See Figure 4.)

a. The augmentor duct is aft of the fan rear duct.

b. The augmentor duct:

- contains the augmentor combustion chamber liner segments
- supports the augmentor nozzle and the augmentor nozzle actuators

c. The augmentor combustion chamber liner encloses the combustion area.

(1) The liner segments protects the augmentor duct from the high gas temperatures.

(2) Perforations along the liner admit the cooler fan air flowing along the duct into the combustion area.

(3) The perforations also aid in suppressing screech.

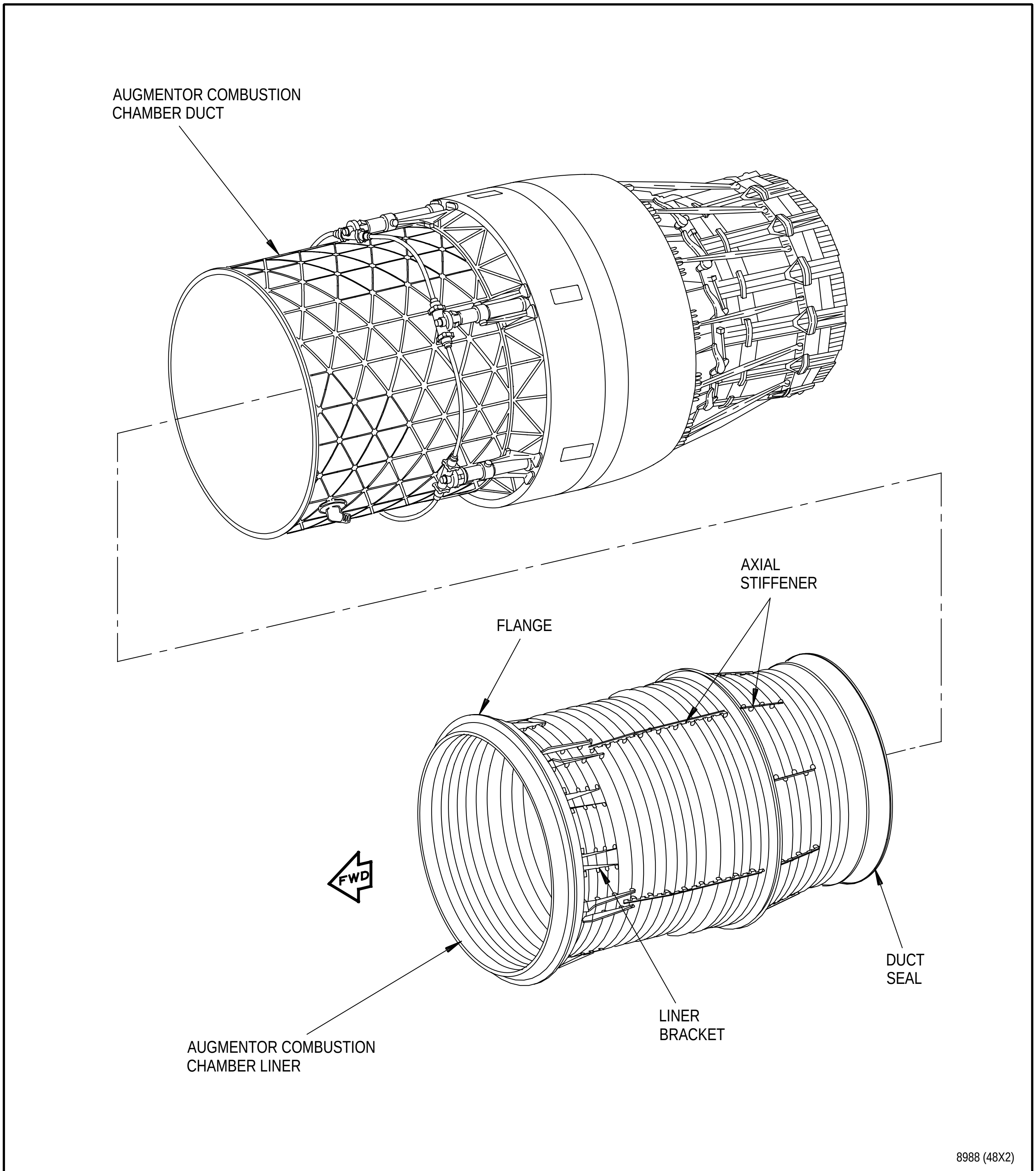


Figure 4. Augmentor Combustion Chamber Duct and Combustion Chamber Liner Segments

7. AUGMENTOR NOZZLE ASSEMBLY AND CONVERGENT NOZZLE BALL SCREW ACTUATORS.

(See Figures 5 and 6.)

a. The augmentor nozzle assembly, located aft of the augmentor duct, consists of dual exhaust nozzles:

- convergent nozzle
- divergent nozzle

(1) The nozzle assembly is variable, allowing the size of each exhaust opening to change, depending on engine thrust requirements.

(2) The convergent-divergent nozzle improves aircraft performance at and above Mach 1 speeds.

b. The convergent nozzle throat area is formed by:

- convergent nozzle segments
- protective convergent nozzle seal segments
- balance nozzle segments
- protective balance nozzle seal segments

c. The convergent nozzle segments are interconnected by a series of connecting links controlled by an augmentor nozzle synchronizing ring contained in the augmentor nozzle support.

d. These segments are actuated by the convergent nozzle actuators. (See figure 5.)

(1) The primary nozzle actuator acts as a transfer box to drive the secondary nozzle actuators. A flexible shaft drives the primary nozzle actuator on signal from the convergent exhaust nozzle control (CENC).

(2) As the actuators move the synchronizing ring, the connecting links respond by rotating the convergent nozzle segment bellcrank levers.

(a) When the synchronizing ring moves rearward as the actuators expand:

- the segments move closer together
- the convergence angle increases
- the throat area decreases

(b) When the synchronizing ring moves forward as the actuators retract:

- the segments push apart
- the convergence angle decreases
- the throat area increases

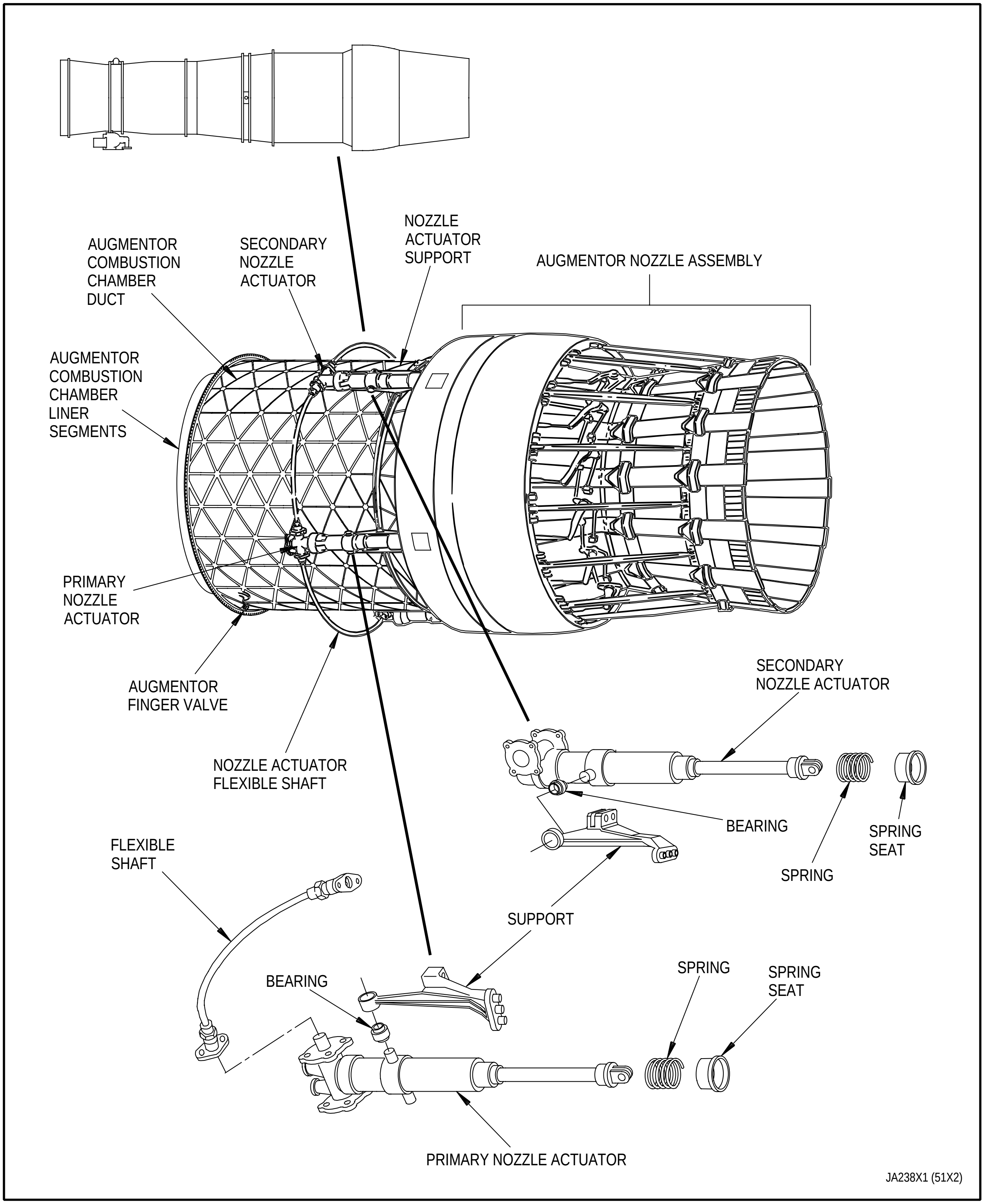


Figure 5. Augmentor Nozzle Assembly and Convergent Nozzle Actuators

e. The balance nozzle segments are hinged to the leading edge of the convergent nozzle segments. (See figure 6.)

f. Engine exhaust gases exert pressure on the convergent nozzle segments. The balance nozzle segments pivot with the convergent nozzle segments, counter balancing the exhaust pressure and stabilizing the position of the convergent nozzle segments.

g. Both the convergent nozzle segments and the balance nozzle segments are protected from the high exhaust gas temperatures by seals which have a heat resistant coating. (See figure 6.)

h. The divergent nozzle consists of:

- divergent nozzle segments
- protective divergent nozzle seals
- divergent nozzle connecting links

i. The divergent nozzle segments are also protected from the high temperatures of the exhaust gases by seals which have a heat resistant coating.

j. The divergent nozzle is free floating. It has no mechanical actuation. Its position depends upon:

- exhaust gas pressure and ambient air pressure on the divergent nozzle segments

k. The divergent exhaust nozzle works independently of, but in unison with, the convergent nozzle to obtain maximum engine/augmentor performance.

l. In the augmentor duct and nozzle module, all nozzle parts, including actuators, flexible shafts, seals and nozzle segments can be replaced at intermediate maintenance.

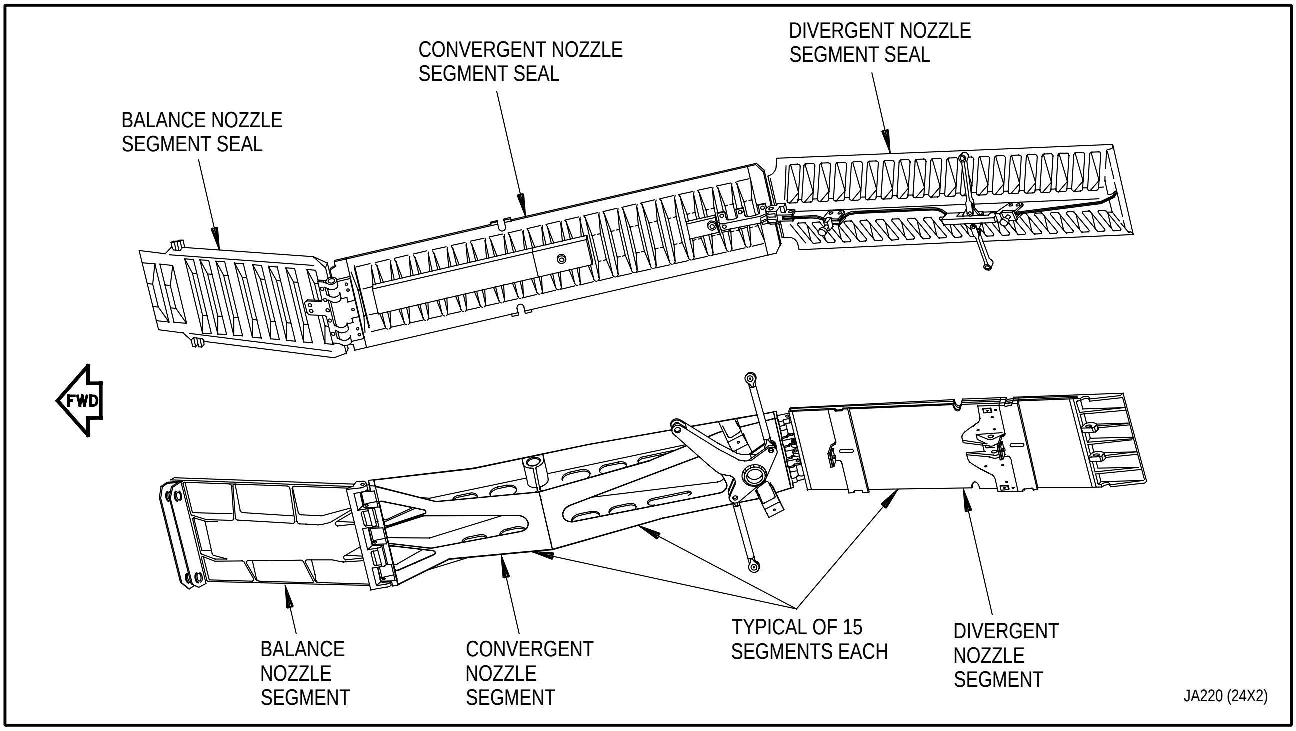


Figure 6. Convergent/Divergent Nozzle Segments and Seals

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - GEARBOX MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
General Engine and System Description - Oil System - - - -	WP 015 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains a description of the gearbox module and its major parts.

2. GEARBOX MODULE.

(See Figure 1.)

a. The gearbox module attaches to the bottom of the compressor intermediate case of the core engine module by two mounting links and a bracket. (See figure 1.)

b. The major parts of the gearbox module are:

- main gearbox assembly
- main oil pump assembly
- oil filter
- breather pressurizing valve
- reduction gearbox. Refer to paragraph 4.

3. MAIN GEARBOX ASSEMBLY.

(See figure 1.)

a. The main gearbox assembly is driven by the rear compressor. (See figure 1.)

(1) The gearbox driveshaft (tower shaft) extends from the gearbox through the compressor intermediate case.

(2) The driveshaft is splined to the gearbox drive bevel gearshaft in the No. 2 and 3 bearing compartment.

b. The gearbox provides mounting pads and drive for:

- main fuel pump
- engine generator (engine electrical systems)

c. Mounting pads are also provided for:

- power take-off (PTO) shaft which powers the airframe mounted accessory drive gearbox
- main oil pump assembly
- oil filter

d. The gearbox also contains:

- No. 2 and 3 bearing scavenge pump
- metal chip detectors
- breather pressurizing valve
- remote gearbox driveshaft coupling

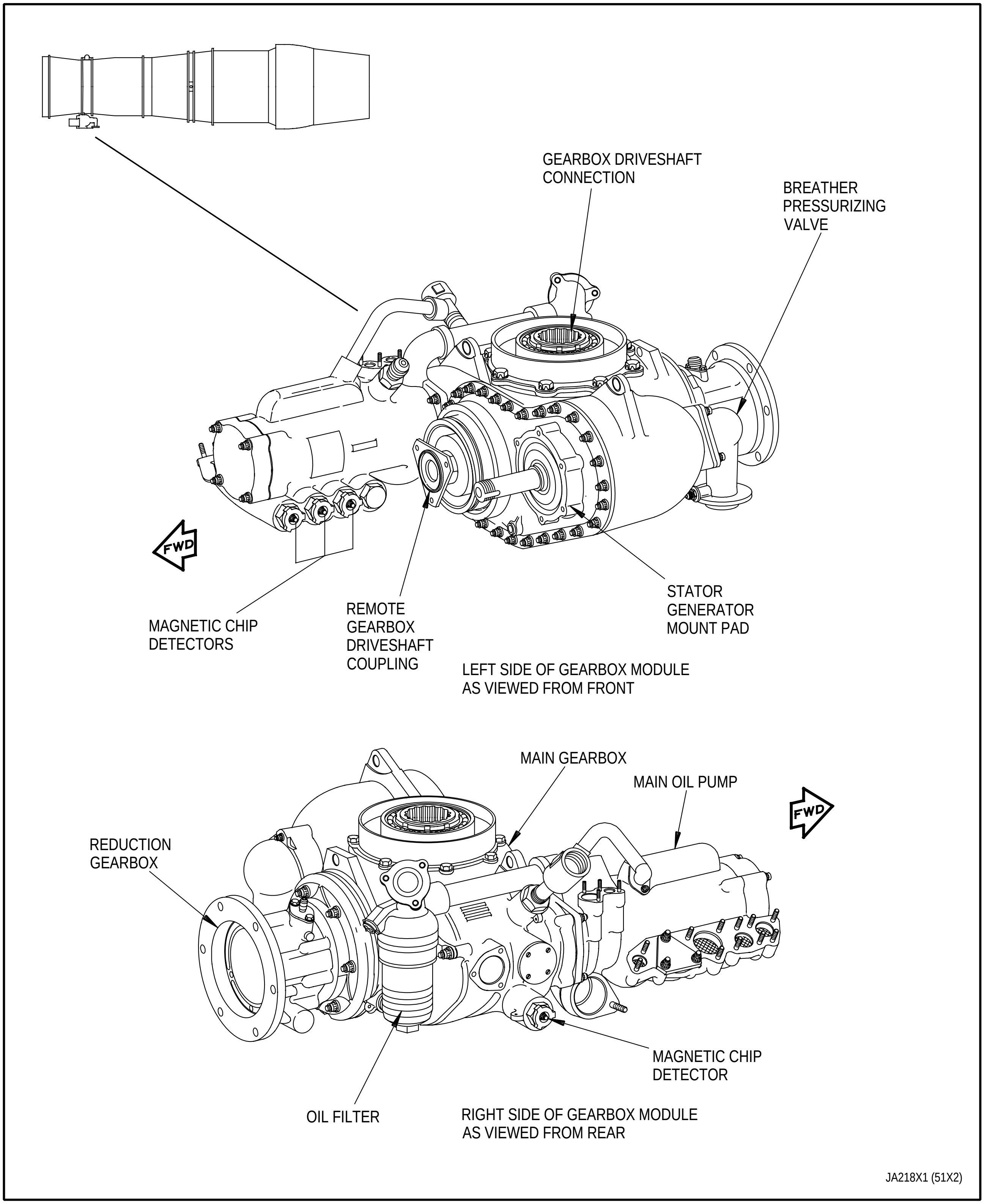


Figure 1. Gearbox Module

4. REDUCTION GEARBOX.
(See Figure 2.)

a. The reduction gearbox is added as part of the gearbox module. (See figure 2.)

b. The reduction gearbox mounts at rear flange of main gearbox.

c. The reduction gearbox incorporates the following:

NOTE

The reduction gearbox permits a 52% speed reduction between the engine driven main gearbox and the main fuel gear pump.

(1) Mount flange for main fuel gear pump.

(2) Internal gear with 29 teeth at front end, which mates with main gearbox bevel gearshaft, and internal splines at rear end, which mates with gear pump driveshaft. Gear is supported by ball bearings and roller bearings.

(3) Bearing nozzle (with strainer element) which provides direct lubrication of bearings and internal gear. Nozzle oil flow rate is approximately 1.00 to 1.20 pounds per minute (at approximately 45 psig) for each hole.

(4) Face seal which provides a boundary separating lubricant from fuel at aft end of reduction gearbox.

(5) Packing between reduction gearbox and main gearbox.

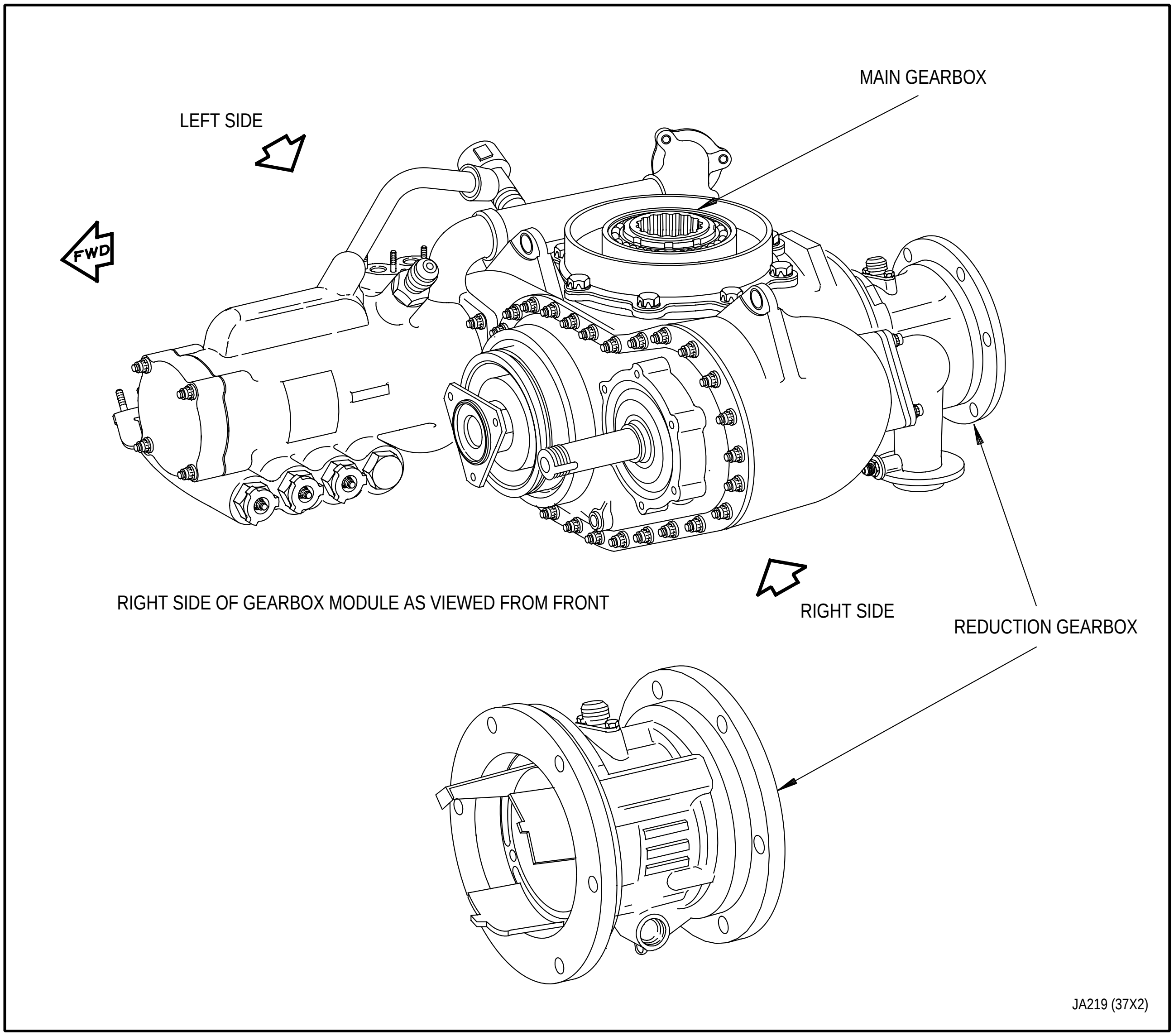


Figure 2. Reduction Gearbox

5. MAIN PUMP ASSEMBLY.
(See figure 1.)

a. The main oil pump assembly is mounted on the front of the main gearbox assembly.

b. The main oil pump assembly contains:

- main pressure pump
- boost pressure pump
- No. 1 bearing scavenge pump
- two No. 4 bearing scavenge pumps
- No. 5 bearing scavenge pumps
- metal chip detectors for the No. 1, 4, and 5 bearing scavenge pumps

c. A more detailed description of the main pump assembly is contained in T.O. 2J-F100-53-1, WP 015 00.

6. OIL FILTER.
(See figure 1.)

a. The oil filter assembly is mounted on the right rear side of the main gearbox assembly.

b. The assembly incorporates a high capacity oil filter and a feature which indicates filter clogging. This design allows the engine to operate with a partially clogged filter.

c. A more detailed description of the oil filter is contained in T.O. 2J-F100-53-1, WP 015 00.

7. BREATHER PRESSURIZING VALVE.
(See figure 1.)

a. The breather pressurizing valve is mounted on the left rear side of the gearbox.

b. It regulates pressure in the:

- gearbox
- No. 2 and 3 bearing compartment
- oil tank

c. A more detailed description of the breather pressurizing valve is contained in T.O. 2J-F100-53-1, WP 015 00.

8. GEARBOX MODULE MAINTENANCE.

a. The gearbox module is designed for replacement of the following parts:

- metal chip detector
- accessory driveshaft seals and generator shaft seals
- main oil pump assembly
- oil filter
- breather pressurizing valve
- strainer element and bearing nozzle (on reduction gearbox)
- No. 2 and 3 bearing scavenge pump
- remote gearbox driveshaft coupling
- No. 1, 4, and 5 scavenge inlet and boost inlet port strainers

b. These components can be replaced at intermediate maintenance without removing the gearbox from the engine.

WORK PACKAGE

GENERAL ENGINE AND SYSTEM DESCRIPTION - FUEL AND CONTROL SYSTEMS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 22

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	6				
2	0				
3	6				
4 - 22	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the engine fuel and control systems.

b. The engine fuel and control systems perform the following functions:

(1) Supply fuel to the engine at proper flow rates from idle to maximum power.

(2) Control engine airflow.

(3) Govern engine operation to prevent it from exceeding limits.

c. Operation of the F100-PW-229 engine is based on integrated functions of:

(1) Main fuel system

(2) Augmentor fuel system

(3) Airflow system

d. In primary mode these systems are controlled by:

(1) Digital electronic engine control (DEEC)

(2) Main fuel control (MFC)

(3) Augmentor fuel control (AFC)

e. In the event of primary mode failure the secondary mode system automatically assumes control of these engine systems.

f. In secondary mode engine systems are controlled by a hydromechanical computer within the MFC.

2. MAIN FUEL SYSTEM.

a. The main fuel system consists of the following components:

- DEEC
- MFC
- Main fuel pump
- Pressurizing and dump valve
- Fuel nozzles

3. DIGITAL ELECTRONIC ENGINE CONTROL. (See Figures 1 and 2.)

a. The DEEC, mounted on the front fan duct 8 o’clock position (figure 1), is a fuel-cooled digital computer which has control of:

(1) Compressor inlet variable vane (CIVV) operation

(2) Rear compressor variable vane (RCVV) operation

(3) Compressor bleed

(4) Anti-ice operation

(5) Gas generator fuel flow (Wfgg)

(6) Augmentor fuel flow in core (Wfac)

(7) Augmentor fuel flow in duct (Wfad)

(8) Segment sequencing valve positions (SVP)

(9) Augmentor nozzle (Aj)

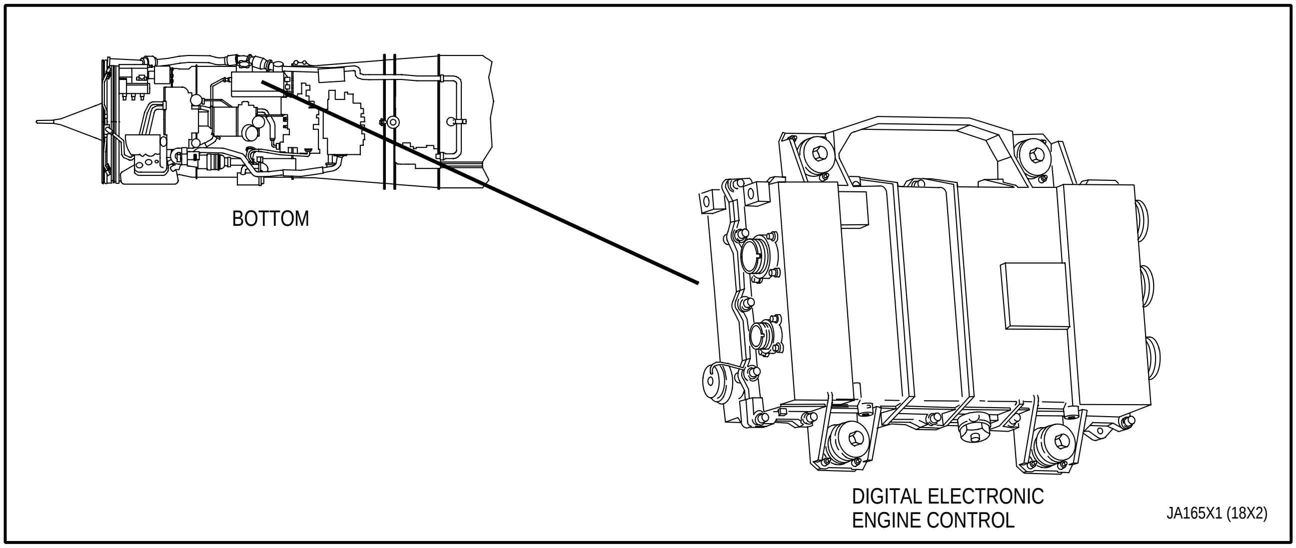


Figure 1. Digital Electronic Engine Control

b. The DEEC receives input signals from four basic sources: (See figure 2.)

- Engine
- MFC
- AFC
- Airframe

(1) From the engine, the DEEC receives electrical signals regarding:

- Fan inlet static pressure (Ps2)
- Burner pressure (Pb)
- Fan turbine discharge pressure (Pt6m)
- Fan inlet temperature (Tt2)
- Fan turbine inlet temperature (FTIT)
- Front compressor speed (N1)
- Rear compressor speed (N2)
- CIVV position
- RCVV position
- CENC position
- Augmentor light-off detector (LOD)

(2) From the MFC, the DEEC receives electrical signals regarding:

- Power lever angle (PLA)
- Metering valve (M/V) position
- Primary/secondary mode switch

(3) From the AFC, the DEEC receives electrical signals regarding:

- Segment sequencing valve position (SVP)
- Core metering valve position
- Duct metering valve position

(4) From the airframe, the DEEC receives electrical signals regarding:

- Mach number (Mn)
- Idle area reset (IAR)
- Ground idle thrust
- Mode select
- Fault reset

c. The DEEC sends signals to four areas:

- Engine
- MFC
- AFC
- Airframe

(1) To the engine, the DEEC sends signals regarding:

- CIVV electrohydraulic valve (EHV)
- CENC EHV
- Light-off detector (LOD)

(2) To the MFC, the DEEC sends signals regarding:

- Metering valve EHV
- Mode select
- RCVV EHV
- Compressor bleed solenoid

(3) To the AFC, the DEEC sends signals regarding:

- SVP
- Core metering valve EHV
- Duct metering valve EHV
- Augmentor ignition

(4) To the airframe, the DEEC sends a signal regarding:

- Augmentor/mn fault

d. The DEEC controls and monitors engine performance, in primary mode. The DEEC controls total engine performance via the following:

(1) Fuel flow is controlled by a computerized schedule in the DEEC that sends signals to the MFC.

(2) Engine pressure ratio (EPR) is controlled by adjusting the exhaust nozzle area or size. Nozzle area is controlled by a computerized schedule in the DEEC that sends signals to the CENC.

(3) To optimize engine performance, the DEEC controls the variable vane and the compressor bleed systems. Adjustment of these systems enables the DEEC to manage the pressure and velocity of the air entering the engine and maximize the compressor stall margin.

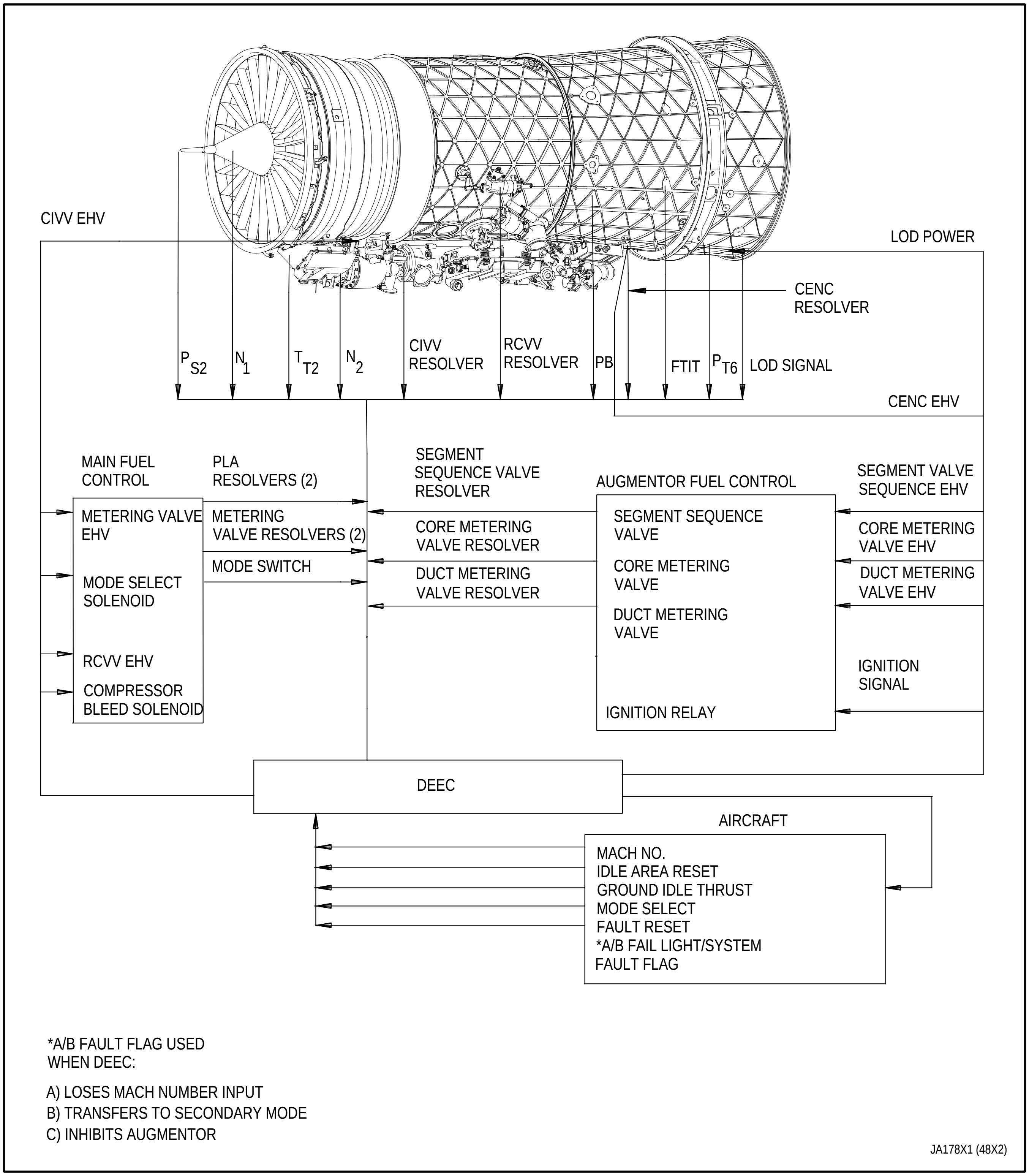


Figure 2. DEEC Operational Diagram

(4) Augmentor performance is controlled by power lever angle (PLA) and fuel/air ratios in the core and duct streams. The fuel/air ratio is controlled by the amount of fuel that the AFC delivers to the augmentor segment manifold. The number of sprayrings that are filled and ignited is determined by PLA.

(5) The DEEC controls engine starting without pilot input under various conditions. The DEEC coordinates engine acceleration rate, fuel flow, FTIT, and Mn to obtain safe, automatic, reliable, and consistent starts.

(6) The DEEC has the capability to detect faults and adjust the engine accordingly. Through a complex network of engine signals, the DEEC computes engine performance faults and reports them to the engine diagnostic unit (EDU).

(7) The DEEC protects the engine by monitoring N1, N2, and FTIT. Control is transferred automatically from the DEEC to a hydromechanical computer within the main fuel control (secondary mode), if speeds or temperature exceed limits.

4. MAIN FUEL CONTROL.

(See Figure 3.)

a. The MFC performs the following functions in primary mode:

(1) Distributes fuel to govern engine starting, steady-state operation, acceleration and deceleration according to signals from the DEEC.

(2) Automatic activation and deactivation of main engine ignition as a function of PLA.

(3) Increase and decrease fuel flow as scheduled by the DEEC.

(4) Actuates RCVV system as scheduled by the DEEC.

(5) Deactivates augmentor metering valve servos during engine start.

(6) Sends redundant PLA position signal to DEEC through resolvers.

(7) Sends redundant fuel metering valve position signal to DEEC.

(8) Sends primary mode signal to DEEC and airframe.

(9) Provides washed/filtered fuel regulated servo pressure to engine servos.

(10) Provides actuation pressure to CIVV control and cylinder.

(11) Actuates compressor bleed system as scheduled by the DEEC.

(12) Provides MFP pressure bypass.

b. The MFC performs the following functions in secondary mode:

(1) Distributes fuel to govern engine starting, steady-stage operation, acceleration and deceleration according to signals received by the hydromechanical computer.

(2) Automatic activation and deactivation of engine main ignition as a function of PLA.

(3) Increase and decrease fuel flow as a function of PLA, Ps2, and Tt2.

(4) Actuates RCVV system.

(5) Sends secondary mode signal to DEEC and airframe.

(6) Provides MFP pressure bypass.

(7) Deactivates augmentor metering valve servos during engine start.

(8) Provides washed/filtered fuel regulated servo pressure to engine servos.

(9) Provides secondary mode Tt2 and Ps2 sensor failure indication to EDU.

(10) Actuates compressor bleed system.

(11) Sends secondary mode pressure signal to AFC, CENC and CIVV control.

(12) Provides PLA rate limiting to prevent uncontrolled PLA input to the MFC during secondary mode operation.

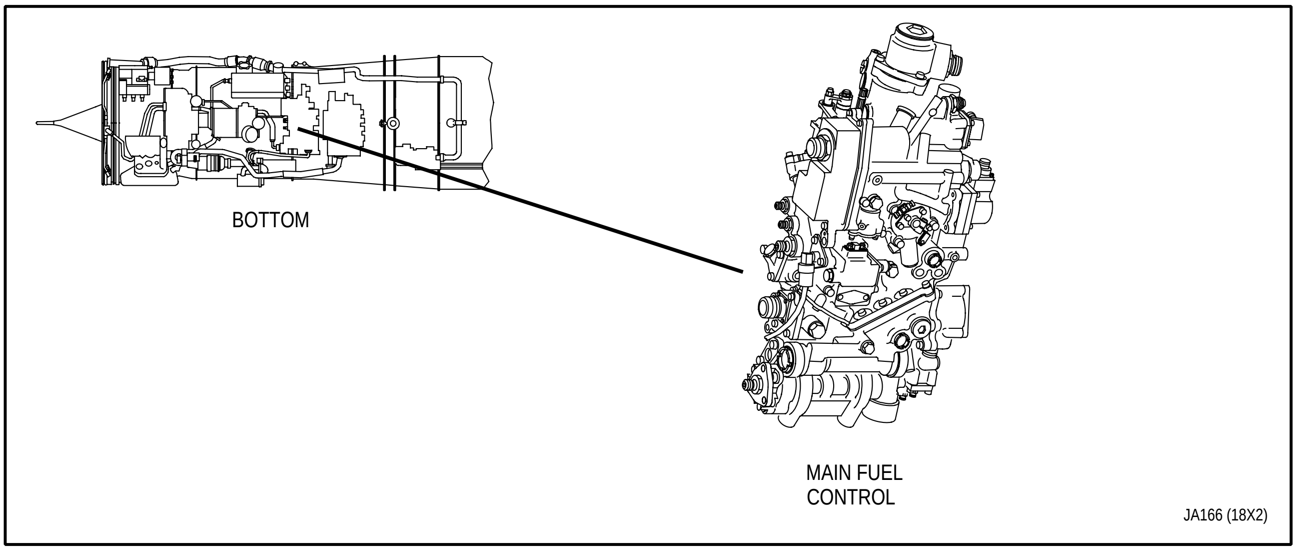


Figure 3. Main Fuel Control

5. MAIN FUEL PUMP.
(See Figures 4 and 5.)

a. The main fuel pump (MFP) mounts on the rear flange of the reduction gearbox. (See figure 4.)

b. The MFP incorporates the following:

(1) Single centrifugal boost stage which supplies fuel to gear stage and to the augmentor fuel pump.

(2) Serviceable filter (35 micron) with disposable element which filters all fuel entering gear stage.

(3) Delta pressure indicator on the filter which extends when pressure drop across the filter is 27 ±2 psid. Extension of the indicator shows impending filter blockage.

(4) Single positive displacement gear stage which supplies fuel to MFC.

(5) Pressure relief valve which limits gear stage differential pressure to safe limits.

(6) Filter pressure relief valve which limits differential pressure across filter element to less than 32 psid.

(7) Wash flow filter to filter fuel used for lubrication of boost stage bearings.

c. The gear pump has a rated pump speed of 7930 rpm. The boost stage provides a total flow of 98,000 pounds per hour of JP-4 at 6905 rpm (pump speed) with a pressure rise of 69 pounds per square inch. The gear stage displacement is 1.81 cubic inches per revolution. The gear stage is sized to provide 19,700 pounds per hour of JP-4 at 7745 rpm (pump speed) with a pressure rise of 1260 pounds per square inch. Pressure relief valves are provided to limit pressures across the gear stage and the filter element to safe levels. See figure 5.

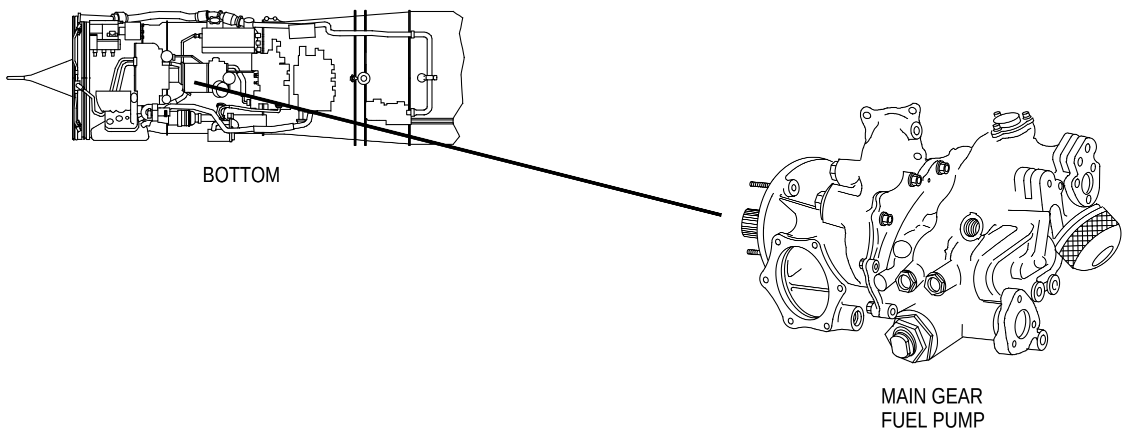


Figure 4. Main Fuel Pump

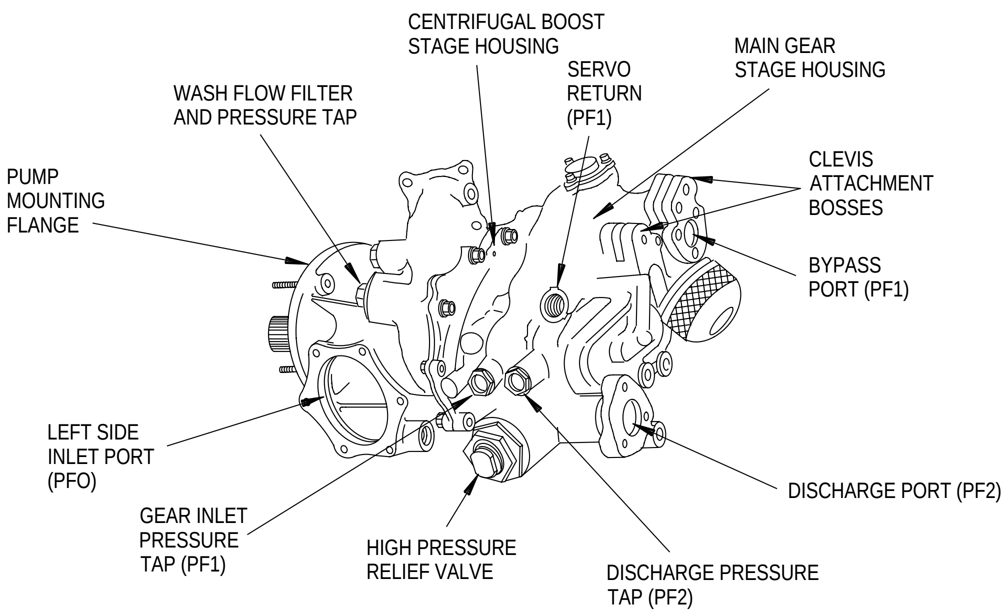


Figure 5. Main Fuel Pump - Flow Diagram

6. FUEL PRESSURIZING AND DUMP VALVE.

a. The fuel pressurizing and dump (P&D) valve is mounted on the main fuel outlet port of the main fuel oil cooler.

b. The P&D valve maintains a minimum pressure level in the main fuel system for the following:

(1) Ensures proper operation of control servos.

(2) Maintains full fuel level at shutdown to minimize subsequent starting time.

7. FUEL NOZZLES.

a. The 24 single tube fuel nozzles are mounted on the diffuser case.

b. Using an air blast principle, the nozzles reduce fuel to a fine spray and deliver it to the core engine combustion chamber.

c. A scheduling valve in each fuel nozzle increases flow area as fuel pressure is increased to maintain a constant flow/ pressure ratio.

8. AUGMENTOR FUEL SYSTEM.

a. The augmentor fuel system consists of the following components:

- DEEC
- Augmentor fuel pump
- Augmentor fuel pump controller
- Augmentor segment manifolds
- Augmentor fuel control
- Light-off detector

b. The DEEC controls augmentor operation.

c. The MFP supplies high pressure fuel to the augmentor fuel pump (AFP). When PLA requests augmentation, the AFC switching valve is activated, which provides the augmentor permission signal (PFAP) that is required to turn on the AFP.

d. The AFP supplies fuel to the augmentor fuel control which meters fuel to the segment manifolds according to signals from the DEEC.

e. Fuel from the nozzles of Segment I is sprayed directly on the flameholder and is directed into an open channel section.

(1) Atomized fuel reaches the pilot burner ring where ignition occurs, forming a pilot flame.

(2) The flame spreads around the pilot burner ring and into the flameholder radial gutters.

(3) The flameholder radial gutters direct the flame inward to the core gaspath and outward to the fan discharge airflow.

f. The AFC increases fuel flow and pressure to the segment manifolds according to signals from the DEEC.

(1) Initially, Segment I is fed with a low pressure flow that produces a soft light and stabilizes fan airflow.

(2) As greater levels of augmentation are requested the segments are pressurized and ignited successively.

(3) As more segments are ignited the AFPC adjusts fuel flow and pressure to produce smooth segment transition and thrust increase.

g. When augmentor fuel flow is cut off, unburned fuel remaining in the segment manifolds is discharged into the gaspath through the fixed orifice discharge holes (venturi principle).

9. AUGMENTOR FUEL PUMP.
(See Figure 6.)

a. The augmentor fuel pump (AFP) is located on the front fan duct at the 4 o'clock position. It is a centrifugal impeller, driven by 13th stage air acting on a turbine, which exhausts into the fan duct.

(1) The AFP supplies fuel pressure to the AFC during engine augmentor operation.

(2) The AFP supplies fuel at the proper pressure and flow for augmentor operation.

b. Pump speed is modulated by the augmentor fuel pump controller (AFPC) to produce the pressure rise necessary to satisfy augmentor fuel system requirements.

c. Fail-safe overspeed protection is provided by a vortex venturi at the turbine exhaust.

(1) The vortex venturi limits pump speed by causing back pressure on the turbine when airflow in the exhaust exceeds the designated limit.

(2) The turbine exhaust air is returned to the fan duct.

d. A 43 micron self-cleaning wash filter is provided for pump discharge fuel which is used for pump bearing lubrication and cooling.

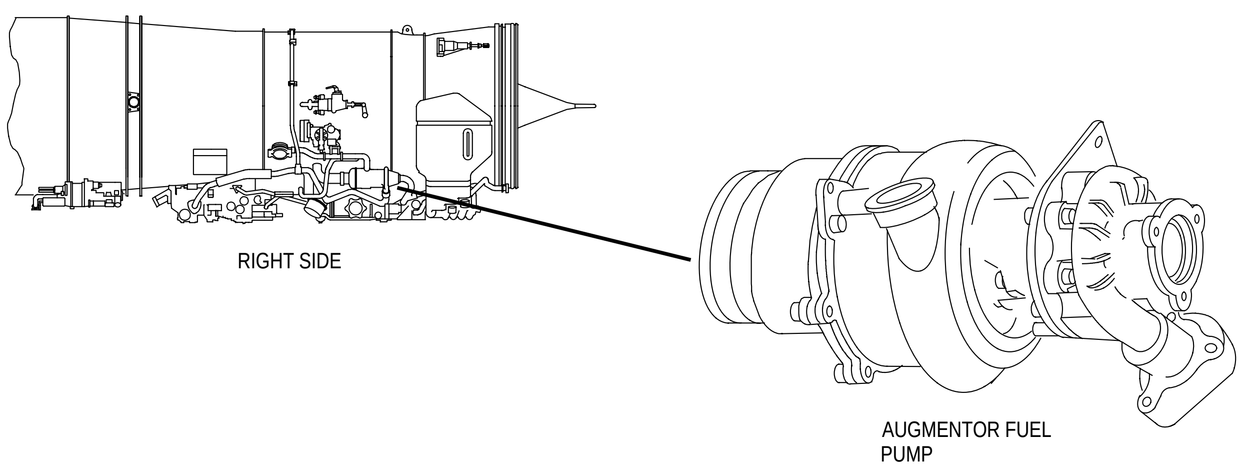


Figure 6. Augmentor Fuel Pump

10. AUGMENTOR FUEL PUMP CONTROLLER. (See Figure 7.)

a. The augmentor fuel pump controller is located on the forward fan duct at the 3 o’clock position.

b. The pump controller controls augmentor pump speed and fuel flow by modulating the butterfly valve located inside the air intake line.

(1) Opening the butterfly valve increases pump speed, fuel flow, and pressure.

(2) During primary nonaugmented and secondary mode operation the AFPC keeps the butterfly valve closed to prevent AFP operation.

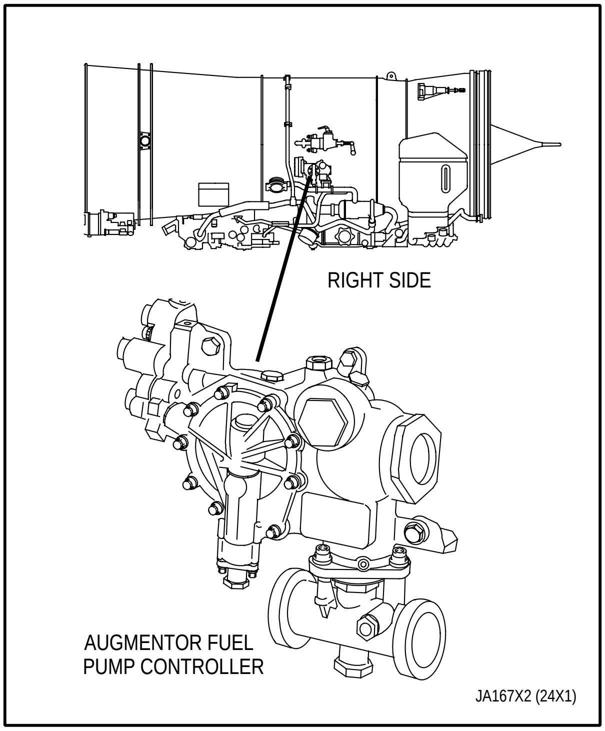


Figure 7. Augmentor Fuel Pump Controller

11. AUGMENTOR SEGMENT MANIFOLD ASSEMBLIES.

a. The augmentor segment manifold assemblies are located in the aft portion of the fan rear duct.

b. The segment manifolds spray fuel into the gaspath for augmentor operation.

c. The segment manifolds supplies fuel to both the hot and cold airstreams.

(1) Segments 1 through 8 supply (core exhaust) airstream (hot).

(2) Segments 9 through 11 supply fuel to the (fan exhaust) airstream (cold).

12. AUGMENTOR FUEL CONTROL.

(See Figure 8.)

a. The augmentor fuel control (AFC) combines the functions of augmentor fuel flow metering and fuel distribution into one component. The AFC is controlled by the DEEC.

b. The AFC performs the following functions.

(1) Activates a segment sequencing valve in response to DEEC request.

(2) The segment sequencing valve activates eleven, three-position segment valves and the AFP.

(3) The segment valves are individually positioned as a function of fuel flow through the AFC.

(4) The metering system consists of a separate core (segments 1 through 8) and duct (segments 9 through 11) metering valves (MV). Metering valve position is fed back to the DEEC by a resolver.

(5) Upon receiving a MFC (Pfmo) secondary mode signal the sequencing valve is positioned to cutoff, preventing augmentor operation.

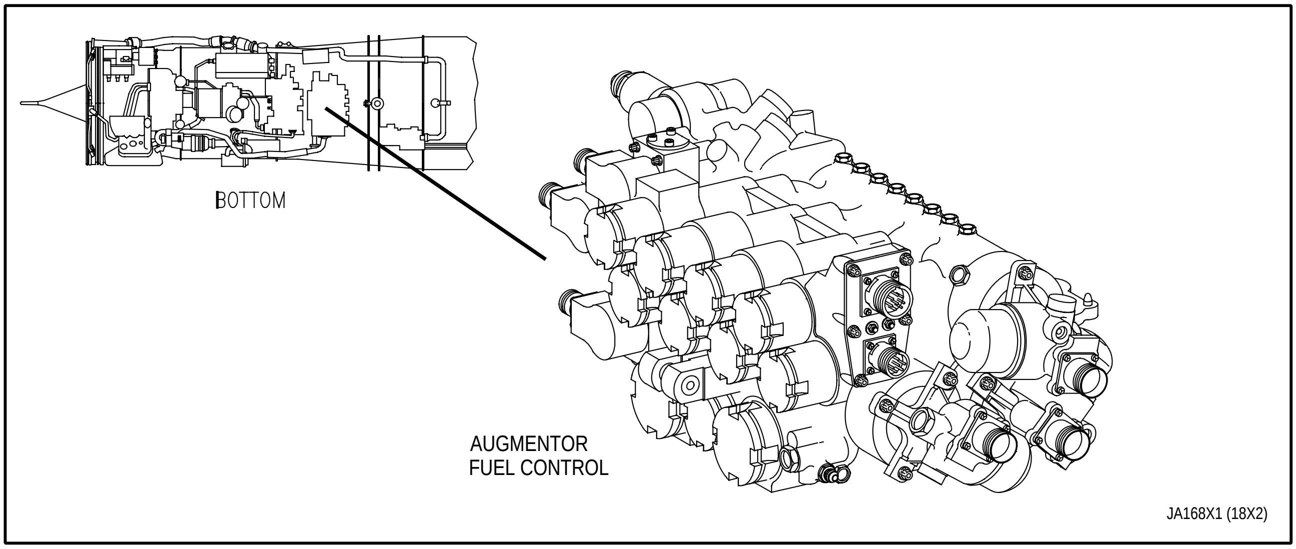


Figure 8. Augmentor Fuel Control

13. AUGMENTOR TOTAL PRESSURE PROBE SYSTEM.
(See Figure 9.)

a. The augmentor total pressure probe is located in the rear fan duct and protrudes into the duct and core streams forward of the segment manifolds and senses turbine exit total pressure (Pt6) for the DEEC.

b. The DEEC uses Pt6 to schedule and control the engine pressure ratio (EPR).

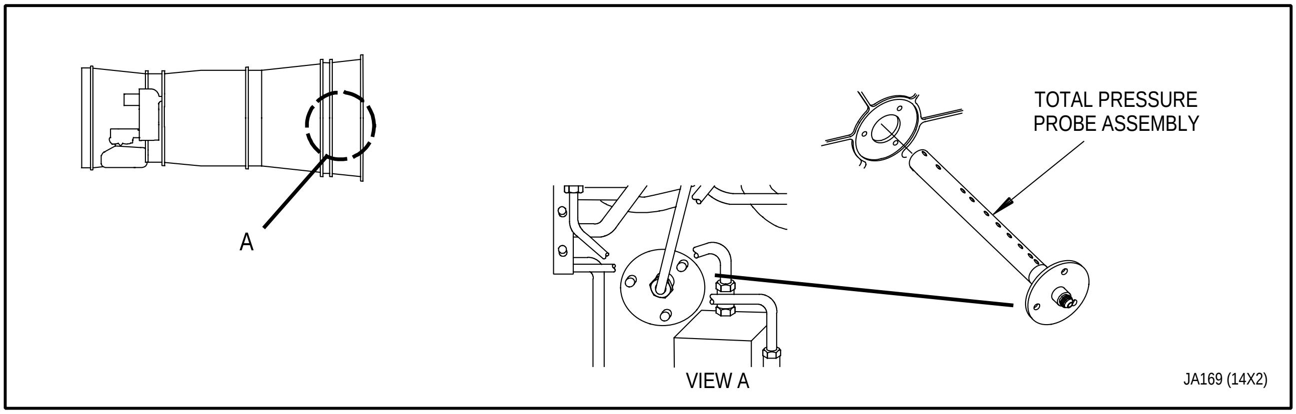


Figure 9. Augmentor Total Pressure Probe Assembly

14. LIGHT-OFF DETECTOR.
(See Figure 10.)

a. The augmentor light-off detector (LOD) is an electrical unit mounted on the augmentor duct.

b. The LOD detects the presence of flame using an ultraviolet sensor tube and provides a signal to the DEEC.

c. The LOD has self-testing capability.

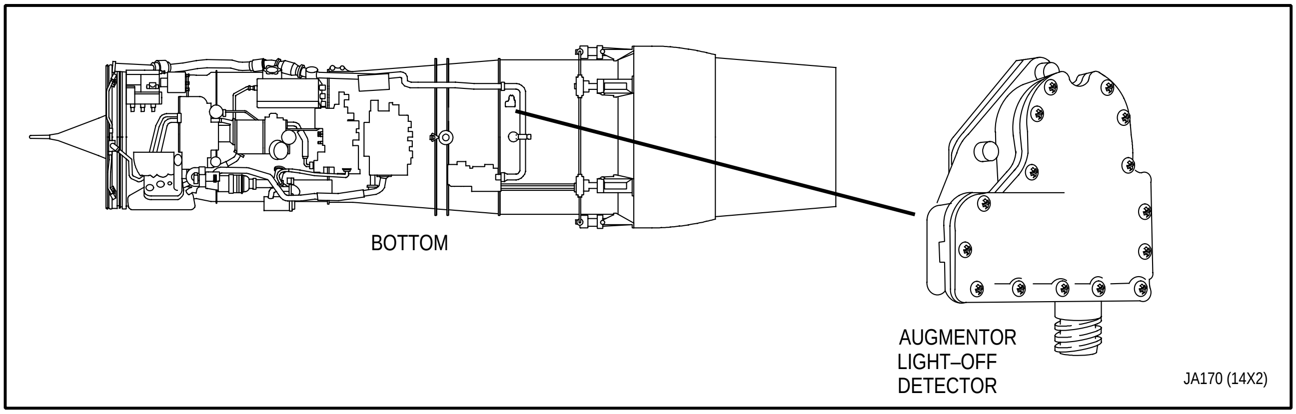


Figure 10. Light-off Detector

15. AIR FLOW SYSTEM.

a. The airflow system manages the flow of air through the engine under all operating conditions.

b. The main system components are:

- Quad N1 sensor
- CIVV system
- RCVV system
- Compressor bleed system
- DEEC

c. In primary mode the DEEC controls engine airflow by adjusting the CIVVs as a function of N1 and Tt2 and the RCVVs as a function of N2, Tt2, and N1C2. The compressor bleeds are scheduled by the DEEC as a function of N2 and Tt2.

d. In secondary mode the hydromechanical computer schedules the RCVVs as a function of PLA and Tt2. The CIVVs are scheduled directly by a pressure signal from the MFC. The compressor bleed is scheduled by a hydraulic timer in the hydromechanical computer and Ps2.

16. QUAD FRONT COMPRESSOR SPEED (N1) SENSOR.

(See Figure 11.)

a. The quad N1 speed sensor incorporates a four-element, variable resistance magnetic sensor mounted in the number one bearing compartment.

(1) It senses the rotation of a serated nut rotating at N1 speed.

(2) The sensor generates an electrical signal with a frequency proportional to N1.

b. The N1 sensor provides information for two functions:

(1) Provides data for scheduling the variable vanes

(2) Provides a feedback signal for the DEEC N1 overspeed circuit

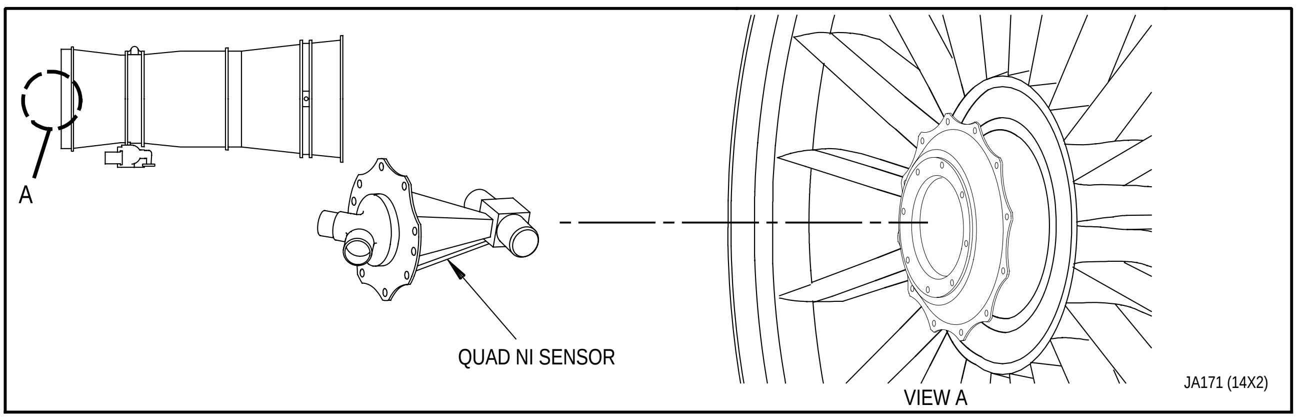


Figure 11. Quad N1 Sensor

17. COMPRESSOR INLET VARIABLE VANE ACTUATION SYSTEM.

a. The CIVV actuation system monitors and sets the operating angle of the vanes in the front compressor.

b. The primary mode CIVV actuation system consists of the following components:

(1) DEEC

(2) CIVV control and cylinder which incorporates an EHV, a transfer valve, feedback resolver, and an actuator

(3) CIVV slave cylinder

c. The DEEC schedules the CIVVs using engine parameters N1 and Tt2 to compute optimum vane angle. Actuator aim position (equivalent to vane angle) is monitored and fed back to the DEEC by the resolver in the CIVV control and cylinder.

d. The DEEC transmits a request current, proportional to the difference between the scheduled and actual vane angle, to the EHV in the CIVV control and cylinder. The EHV translates the DEEC request into extend and retract hydraulic pressure signals to actuate the cylinders.

e. A Pfmo signal from the MFC activates a transfer valve in the CIVV control and cylinder for secondary mode operation. The transfer valve directs high pressure fuel into the retract port adjusting the CIVVs to the full camber position during secondary mode operation.

18. REAR COMPRESSOR VARIABLE VANE ACTUATION SYSTEM.

a. The RCVV actuation system monitors and sets the operating angle of the vanes in the rear compressor.

b. The primary mode RCVV actuation system consists of the following components:

(1) DEEC

(2) RCVV EHV located on the MFC

(3) Two RCVV cylinders with integral resolvers

c. The DEEC schedules the RCVV using engine parameters N1, N2 and Tt2 to compute optimum vane angle. Actual vane angle is monitored and fed back to the DEEC by the cylinder resolvers.

d. The DEEC transmits a request current, proportional to the difference between the scheduled and actual vane angle, to the EHV on the MFC. The EHV translates the DEEC request into extend and retract hydraulic pressure signals to actuate the cylinders.

e. In secondary mode the extend and retract hydraulic pressure signals are produced by the hydromechanical computer. The hydromechanical computer uses engine parameters PLA and Tt2 to compute optimum vane angle. Actual vane angle is fed back to the MFC via the push-pull control cable. The hydromechanical computer provides retract and extend pressure signals proportional to the difference between the scheduled and actual vane angle.

19. COMPRESSOR BLEED ACTUATION SYSTEM.

a. The compressor bleed actuation system controls the opening and closing of the compressor bleed.

b. The primary mode compressor bleed system consists of the following components:

(1) DEEC

(2) Bleed solenoid, transfer valve and bleed spool valve contained within the MFC

(3) Compressor bleed cylinder

c. The DEEC schedules the compressor bleeds using engine parameters N2 and Tt2.

d. The DEEC signals the compressor bleed solenoid which produces either a high or low pressure signal. The signal is ported through the transfer valve to position the compressor bleed spool valve. The spool valve then ports the pressure signal to the open and close ports of the compressor bleed cylinder.

e. In secondary mode the hydromechanical computer in the MFC schedules the compressor bleeds with an integral timer and Ps2.

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - ELECTRICAL SYSTEM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 11	0				
12 Blank	0				
13	0				
14 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
General Engine and System Description - Fuel and Control System	WP 013 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the engine electrical system.

2. ELECTRICAL SYSTEM.

(See Figures 1 through 8 and FO-1.)

a. The engine has a self-contained engine driven generator to provide electrical power for engine control and ignition.

b. This internal power source assures starts and safe engine operation at all speeds from ground idle through maximum augmentation, even if externally supplied (airframe) power is lost.

c. External power is required to actuate the anti-icing valve and power the engine diagnostic unit (EDU).

d. The electrical system is made up of three subsystems:

- Engine generator (rotor and stator)
- Ignition
- Engine Diagnostic Unit

3. ENGINE GENERATOR ROTOR AND STATOR. (See figure 1.)

a. The generator rotor and stator are separate units which together make up the engine generator.

b. The engine generator is driven directly by the engine gearbox.

(1) It is a self-contained electrical power supply for the engine control and ignition systems. Refer to T.O. 2J-F100-53-1, WP 013 00.

(2) The driveshaft and bearing assembly are an integral part of the engine gearbox.

(3) The engine generator is a two section, 18 pole, permanent magnet, alternating current generator. Separate windings are provided for each engine electrical requirement.

c. In the outer section (closest to the connector end), two windings provide power to the main ignition system and two windings provide power to the augmentor ignition system. (See figure 1.)

(1) The two main ignition system windings provide sufficient energy at approximately 10% N2 rpm.

(2) The augmentor ignition system winding provides sufficient energy at approximately 61% N2 rpm.

d. This same generator section has a winding that supplies unregulated voltage to the Ps2 probe heater and a winding that supplies N2 signal for the EDU and for vehicle cockpit indication.

e. In the inner section (closest to the drive end), a set of windings provides three phase high voltage to the digital electronic engine control (DEEC).

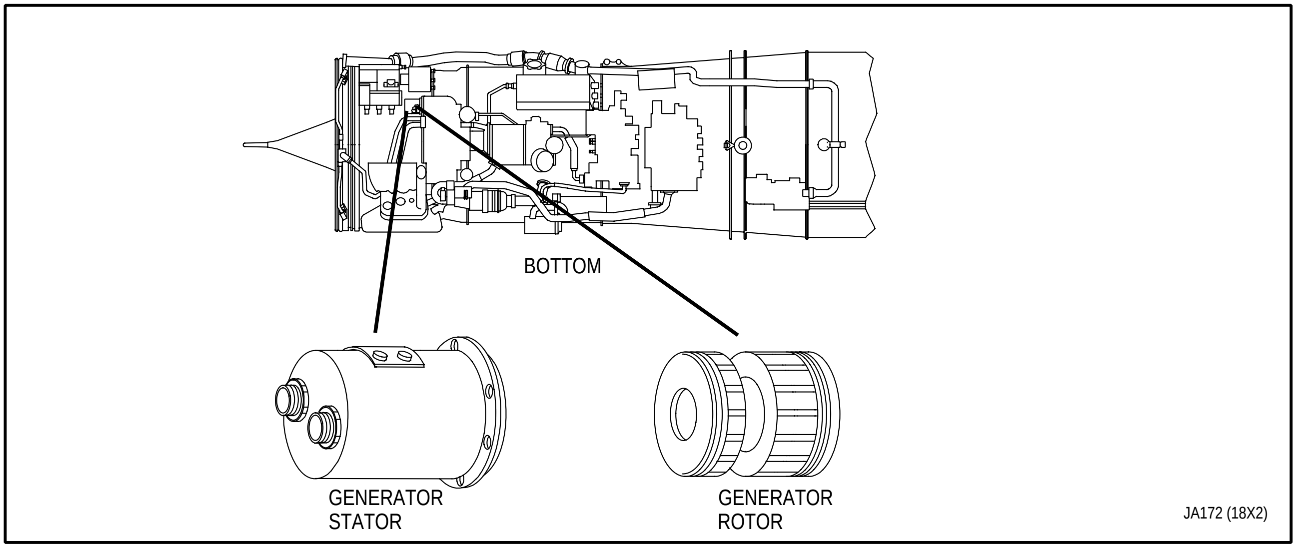


Figure 1. Engine Generator

4. IGNITION SYSTEM.
(See figures 2 through 5.)

a. The engine ignition system has two electrically independent circuits:

- engine ignition
- augmentor ignition

b. The engine and augmentor ignition systems consist of an engine driven generator, two dual output exciters, two main igniters, and two augmentor igniters.

(1) Each dual exciter has two independent circuits that provide electrical energy to one of the engine igniters and one of the augmentor igniters through high tension leads.

(2) The engine igniter discharge rate is one to five sparks per second at a nominal 4 joules, stored energy. The augmentor rate is a minimum of 30 sparks per second at a nominal 2.6 joules, stored energy.

c. The augmentor ignition circuits are turned on and off automatically by the DEEC. The ignition circuits are controlled as a function of PLA.

(1) Engine ignition is activated and is on continuously whenever the power lever is above approximately 10 degrees.

(2) The augmentor ignition system is activated by a solenoid in the augmentor control when power lever is placed in the augmentor zone.

(a) The augmentor spark igniters are activated for 1.3 seconds or until the light-off detector (LOD) detects an augmentor light (whichever comes first).

(b) If the LOD does not detect a light the igniters are automatically deactivated for 1 second while the DEEC performs a test of the LOD. If the LOD test is good, the DEEC accepts augmentation again. This is repeated two more times total of four attempts or until the LOD detects a light (whichever comes first).

(c) If an augmentor light is not achieved, the pilot must retard the throttle to Intermediate (MIL) and readvance to augmentation in order to reactivate the ignition circuit.

d. All engine electrical component housings and internal and external shields of harnesses not connected to the digital electronic engine control (DEEC) or the engine diagnostic unit (EDU) are grounded to the engine. The grounding requires a bond strap connection from the airframe to the engine.

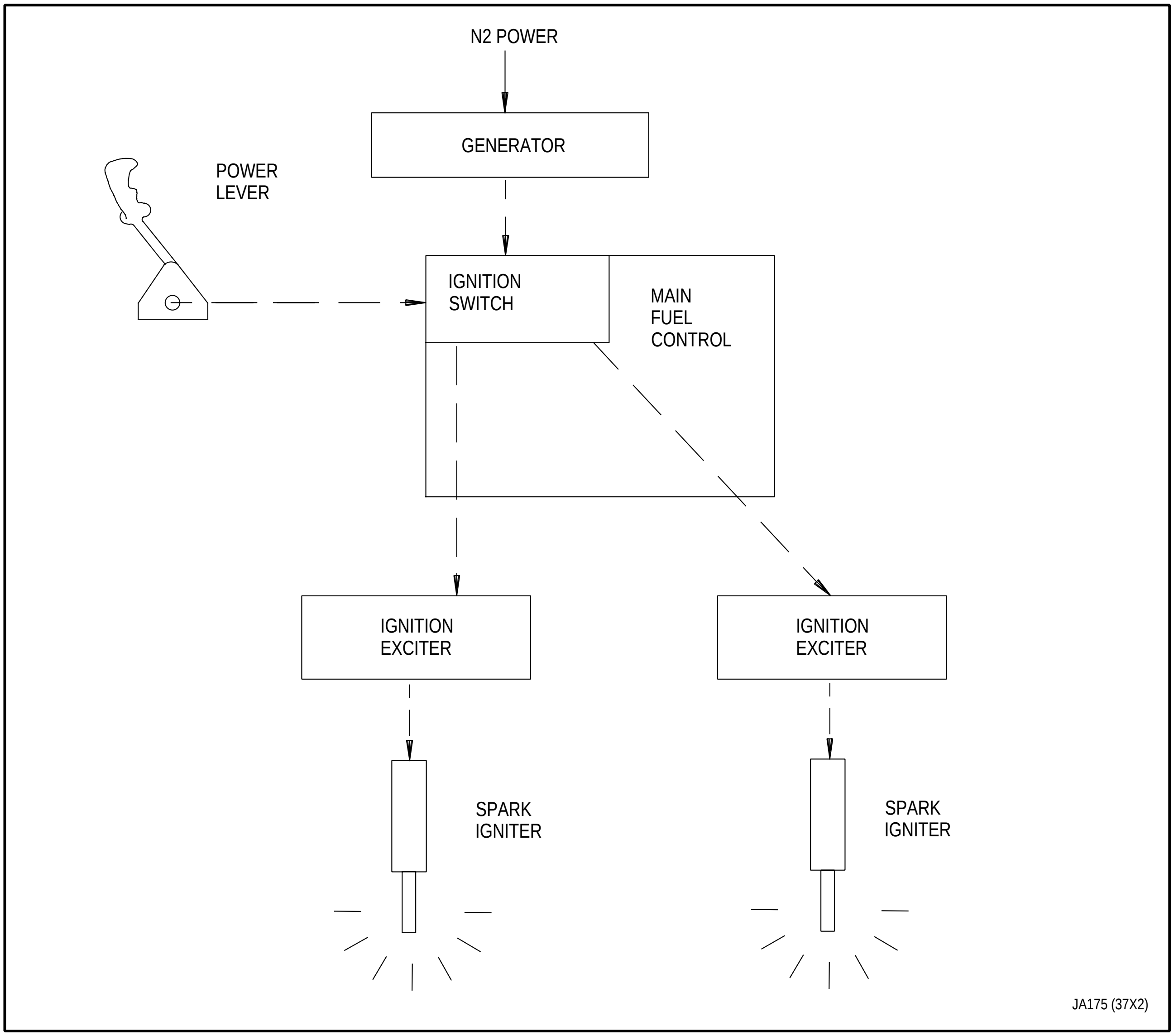


Figure 2. Gas Generator Ignition - Schematic

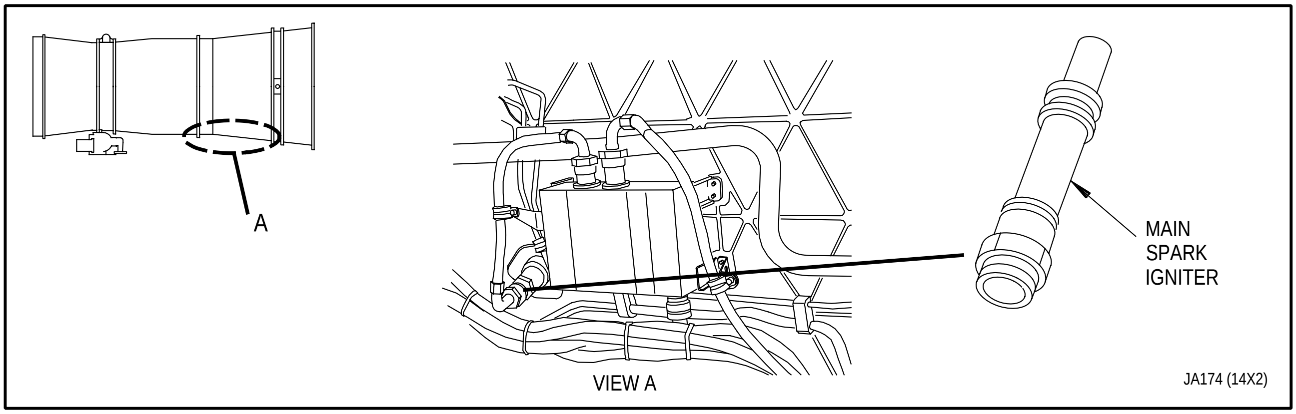


Figure 3. Engine Main Spark Igniter

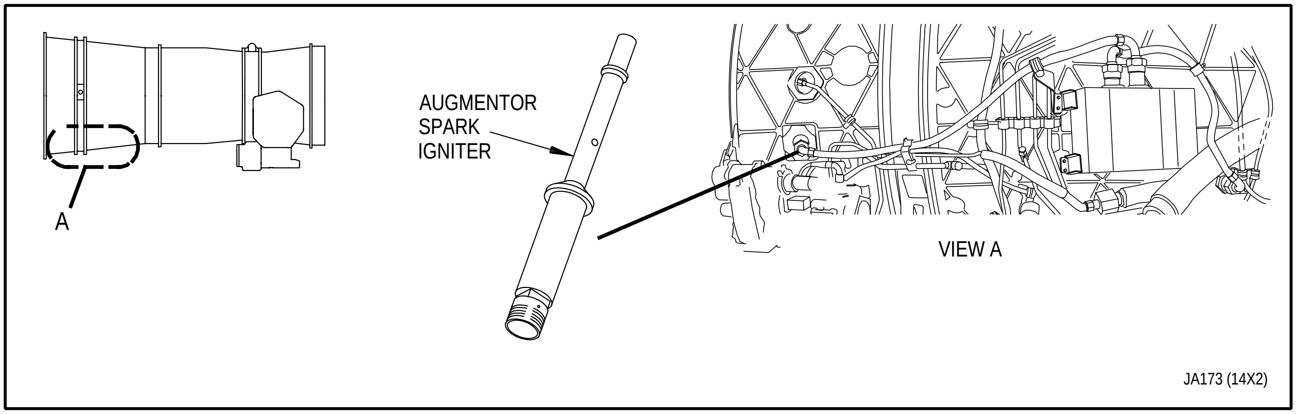


Figure 4. Augmentor Spark Igniter

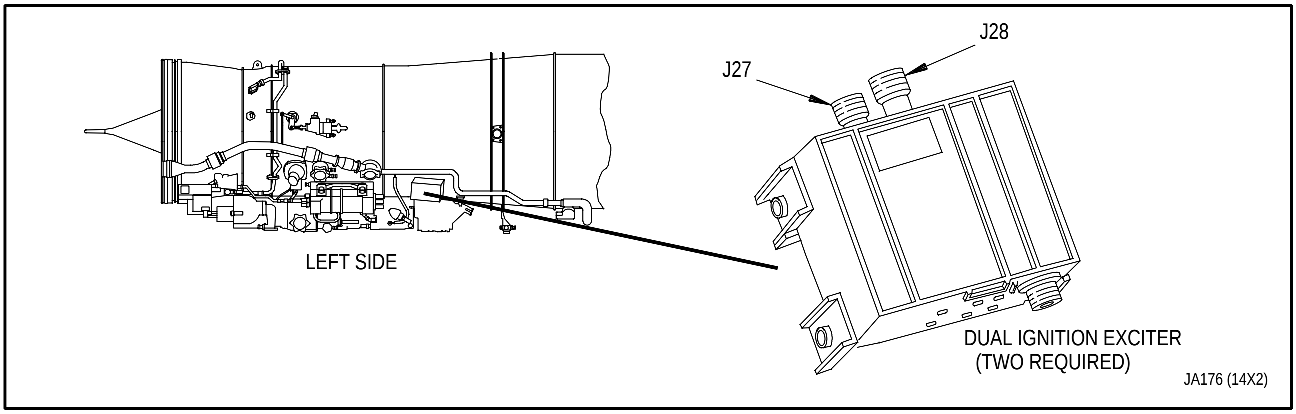


Figure 5. Engine Dual Exciter

5. ENGINE DIAGNOSTIC UNIT.
(See Figure 6.)

a. The engine diagnostic unit (EDU) is a self-contained microcomputer that obtains electrical power from the aircraft electrical system.

b. The EDU is mounted on the engine at the 8 o'clock position. It operates in conjunction with the DEEC to acquire and record diagnostic data when the engine is running. EDU data can be collected with the data collection unit (DCU) for viewing by ground support personnel.

c. The EDU records information for six basic data groups described as follows:

(1) Time/cycle data: The EDU records engine, hot section and augmentor operating times under various conditions. In addition it accumulates low cycle fatigue counts and engine flight hours.

(2) Event data: The EDU monitors the engine for over limit conditions and anomalies. The data can be used to verify a pilot reported anomaly and to assess resulting maintenance requirements. Event/anomaly data is recorded as a 1000 series fault code.

(3) Fault data: The EDU records engine control system, DEEC, and EDU faults. DEEC faults are displayed as 2000 series codes, EDU faults are 3000 series and control system faults are 4000 series.

(4) Operator requested data: The engine test operator has the option of requesting the EDU to record a group of common engine parameters for any 4 1/2 second period of time.

(5) Performance data: The EDU monitors and records various engine parameters under different conditions for use by ground test equipment in calculating engine performance.

(6) Documentary data: The EDU contains information required to maintain EDU and DEEC configuration records and serial numbers.

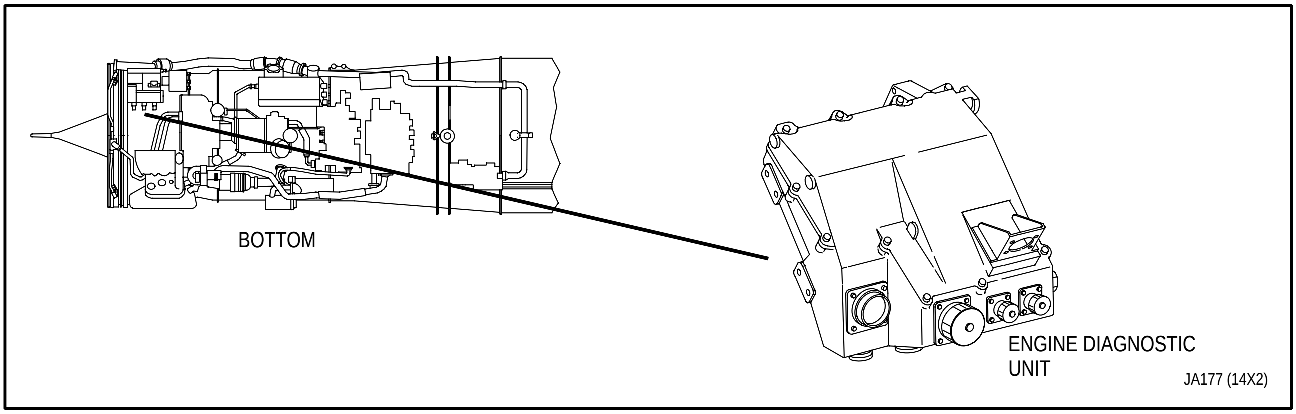
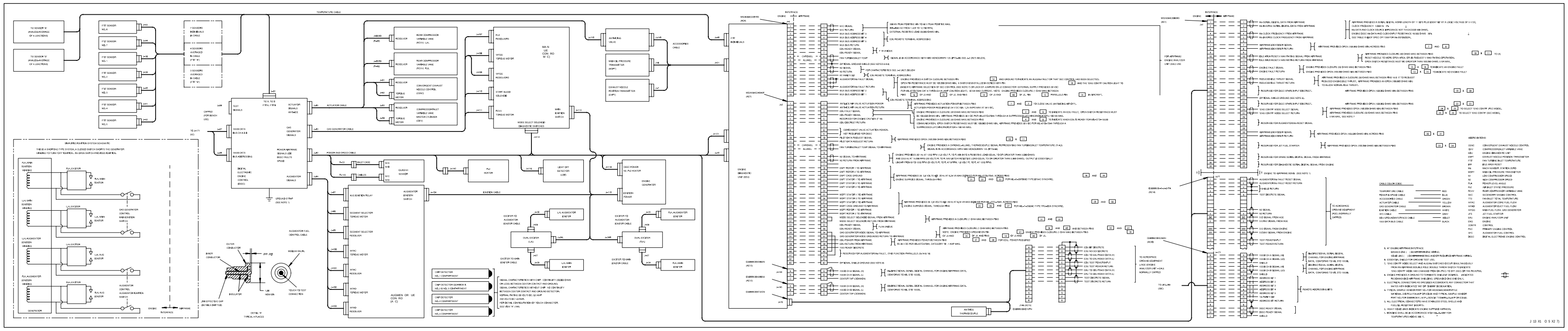


Figure 6. Engine Diagnostic Unit (EDU)



FO-1. Electrical System Schematic

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

OIL SYSTEM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	13	5 - 9	0	11 - 13	0
3	0	10	13	14 Blank	0
4	13				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

T.O. No.	Date	Level	Title (ECP No.)
T.O.2J-F100229(V)-501	1 Jan 95	O/I	Incorporation Of 30 Micron Oil Filter With Full-Flow Bypass Valve, F100-PW-229Engines, F-15/F-16 Aircraft(ECP 90QA168C1)

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the engine oil system.

2. OIL SYSTEM.

(See Figures 1 through 6 and FO-1.)

a. The engine has a hot tank oil system to lubricate and cool the engine bearings.

b. The oil system includes:

- Oil pressure system
- Oil scavenge system
- Oil breather system

c. Oil system components include:

- Breather pressurizing valve
- Oil filter
- Fuel oil cooler
- Oil tank
- Chip detectors
- Main oil pump

d. Oil from the tank is supplied to the main oil pump inlet.

(1) It is pressurized and routed through a main oil filter to the bearing compartments and the engine gearbox.

(2) Oil is scavenged from the bearing compartments and returned to the oil tank through an internal deaerator.

(3) A breather system maintains positive pressure throughout the oil system.

3. BREATHER PRESSURIZING VALVE.

a. The breather pressurizing valve is internally mounted in the gearbox.

b. It regulates pressure in:

- Gearbox
- No. 2 and 3 bearing compartment
- Oil tank

c. The breather valve seat is held open by an evacuated bellows during low altitude operation. This maintains gearbox pressure at ambient (outside air) pressure.

d. During high altitude flight, gearbox pressure is regulated by a spring poppet within the breather valve.

e. The breather pressurizing valve operates as follows:

• 0 to 23,000 feet	Bellows operation holds poppet valve open with breather pressure equal to ambient (outside air) pressure.
• 23,000 to 30,000 feet	Bellows valve starts to close at 23,000 feet and is fully closed at 30,000 feet.
• Above 30,000 feet	Poppet valve starts opening at 1.5 psid. Poppet valve fully open at 2.0 psid.

4. OIL FILTER.

a. There are two oil filter configurations. One configuration is a full flow nonbypass-type 70 micron filter. The other configuration is a full flow 30 micron disposable filter with a bypass valve.

b. The oil filter head has a pop-out button to indicate a need for maintenance.

(1) The pressure differential indicator (ΔP) is a red button that pops out and remains extended when the pressure difference across the element exceeds 35 psid for temperatures greater than 180°F (82°C).

(2) A temperature sensitive detent prevents full actuation of the (ΔP) indicator when the oil temperature is below 180‘F (82‘C).

c. The oil filter head contains poppet check valves which prevent oil loss when the filter bowl is removed.

d. The 30 micron filter assembly has a filter element bypass valve to insure uninterrupted oil flow to the bearing compartments if the filter should become obstructed. If the pressure becomes 47 to 57 psid across the filter, the filter bowl indicator will pop out to warn maintenance personnel that the bypass valve opening pressure has been reached and maintenance action is required to determine the source of filter contamination. The indicator has a temperature sensitive detent which prevents full actuation of the (ΔP) indicator when the oil temperature is below 180°F (82°C). This indicator cannot be reset unless the filter bowl is removed and inverted.

5. FUEL OIL COOLER.

(See figures 1 and 2.)

a. The fuel oil cooler provides cooled oil to the bearings and gears.

b. The fuel oil cooler:

- is mounted externally on the front fan duct at the 4 o’clock position.
- uses gas generator fuel as the coolant.

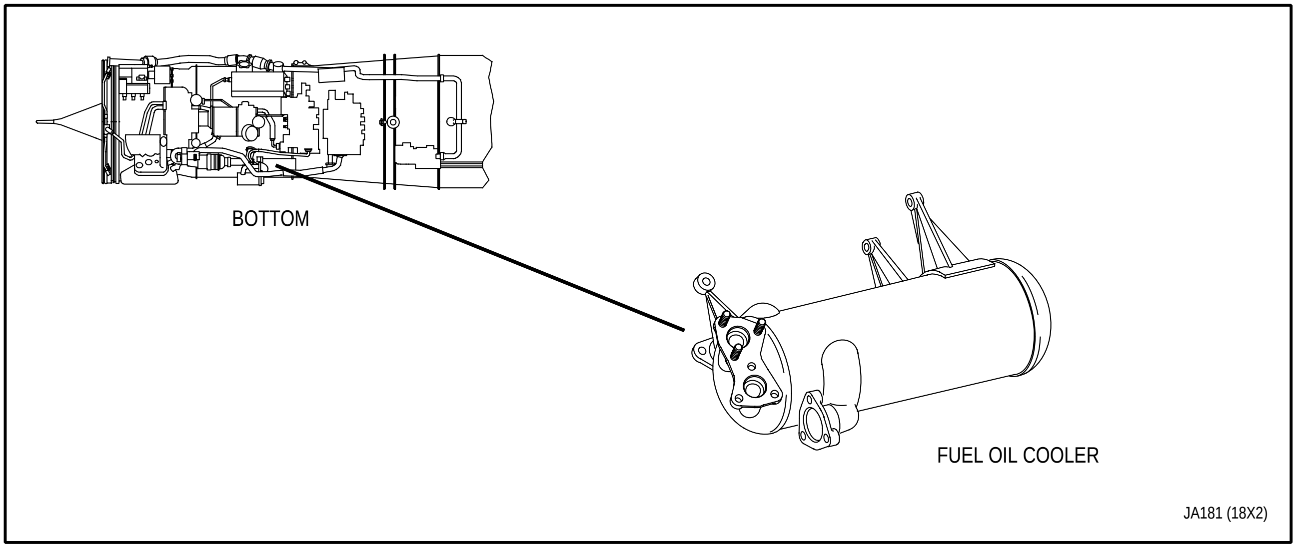


Figure 1. Fuel Oil Cooler

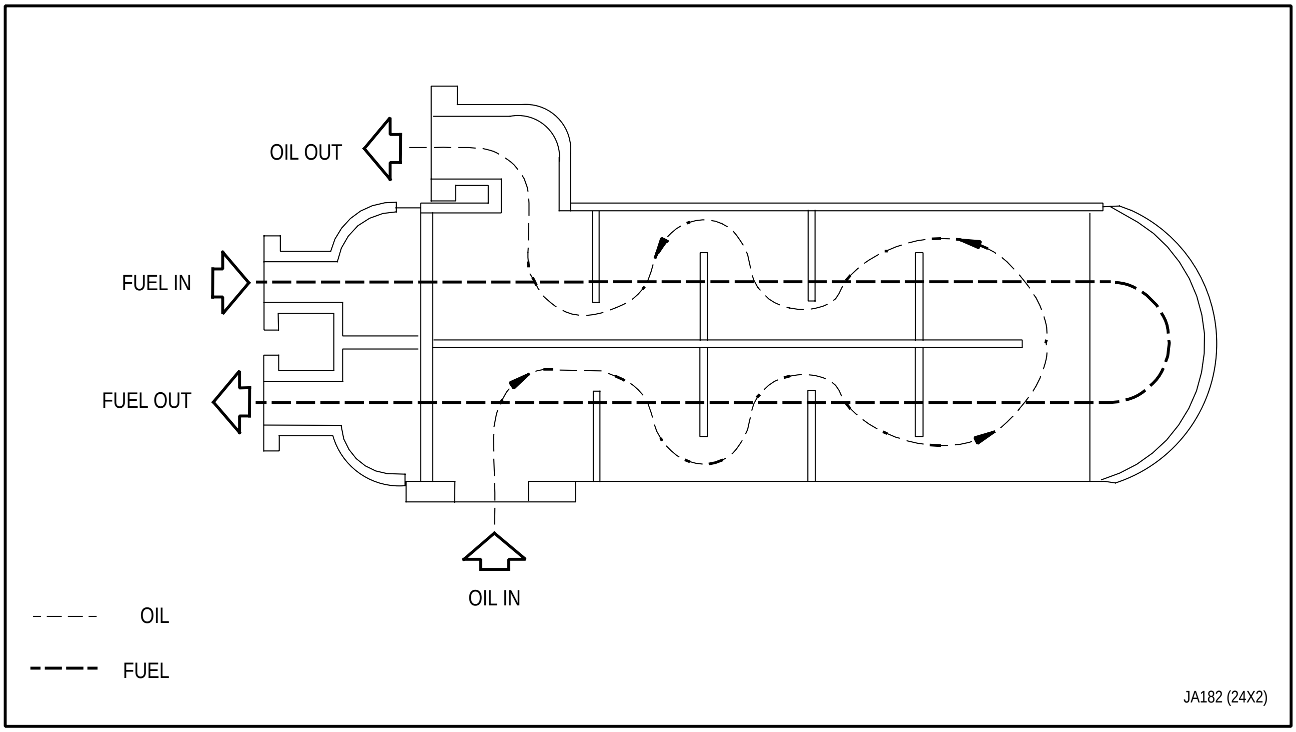


Figure 2. Oil Cooler Flow Diagram

6. OIL TANK.
(See figures 3 and 4.)

a. The oil tank is a lightweight welded sheet metal container contoured to the exterior of the engine.

b. A fitting in the bottom of the tank allows the tank to be drained and flushed easily.

c. The oil tank has provisions for remote filling and overflow and a gage to indicate the oil level.

d. The oil tank has two internal breather lines, one inverted, to allow the oil tank to operate in the inverted position.

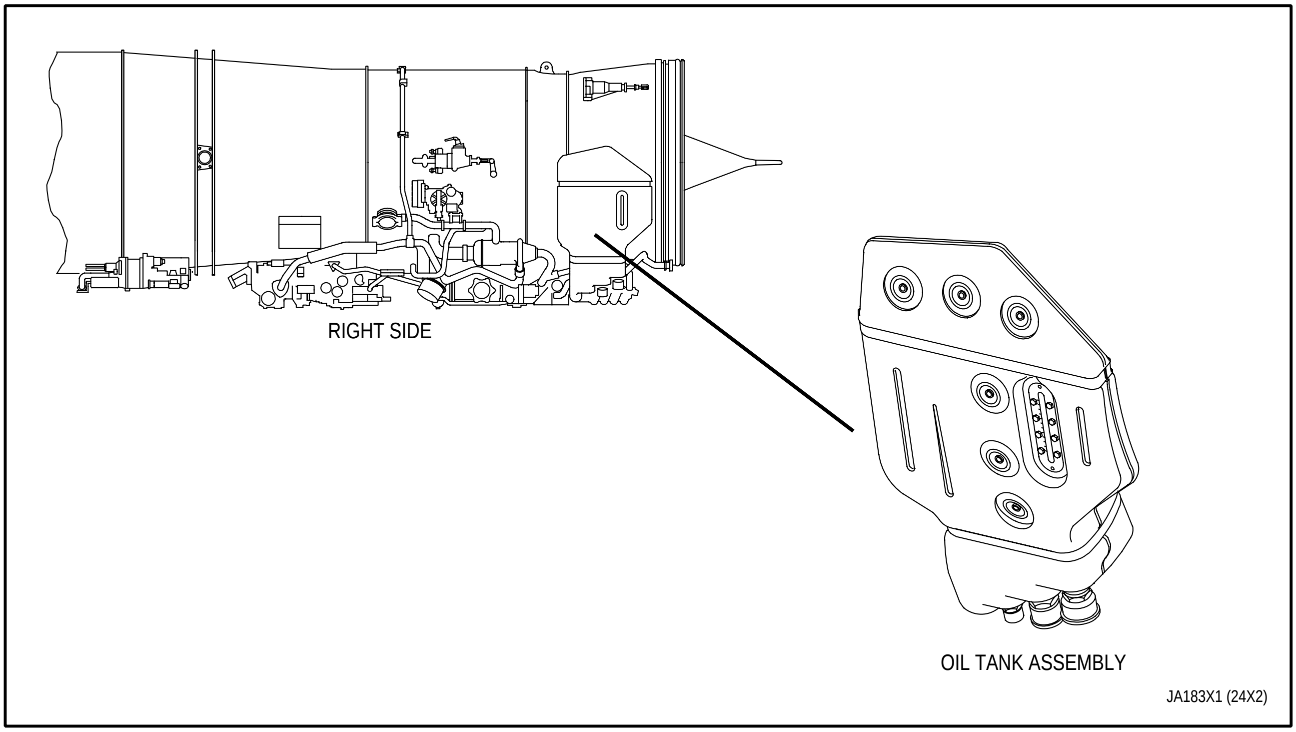


Figure 3. Oil Tank

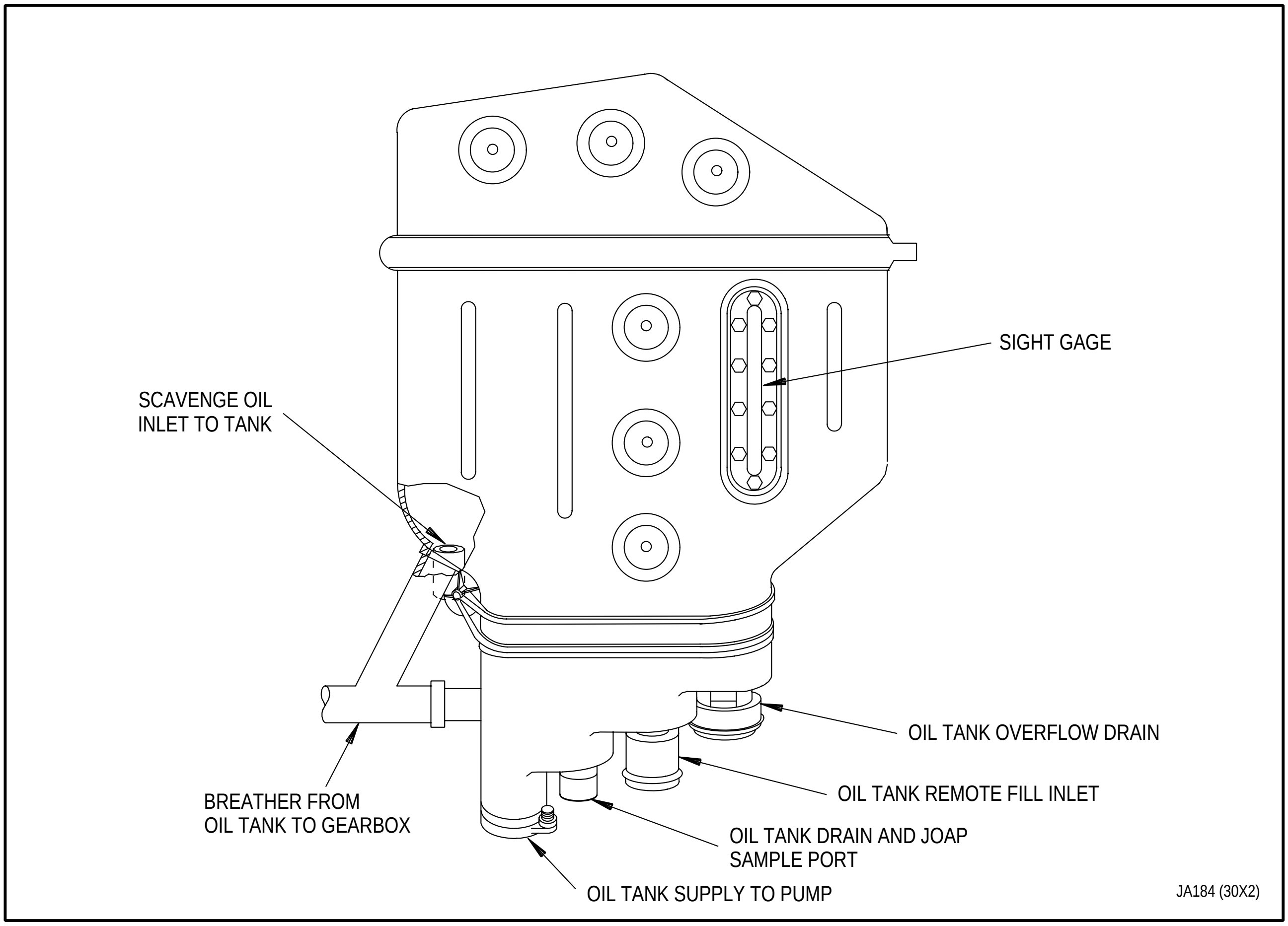


Figure 4. Oil Tank - Flow Diagram

7. CHIP DETECTORS.

(See figure 5.)

a. Chip detectors are located at:

- main gearbox sump for the No. 2 and 3 bearing
- main oil pump for the No. 1, 4 and 5 bearings

b. These chip detectors are a diagnostic maintenance aid in early detection of failure in:

- engine bearings
- gears
- oil pumps and associated parts

c. Chip detectors can be easily removed for inspection.

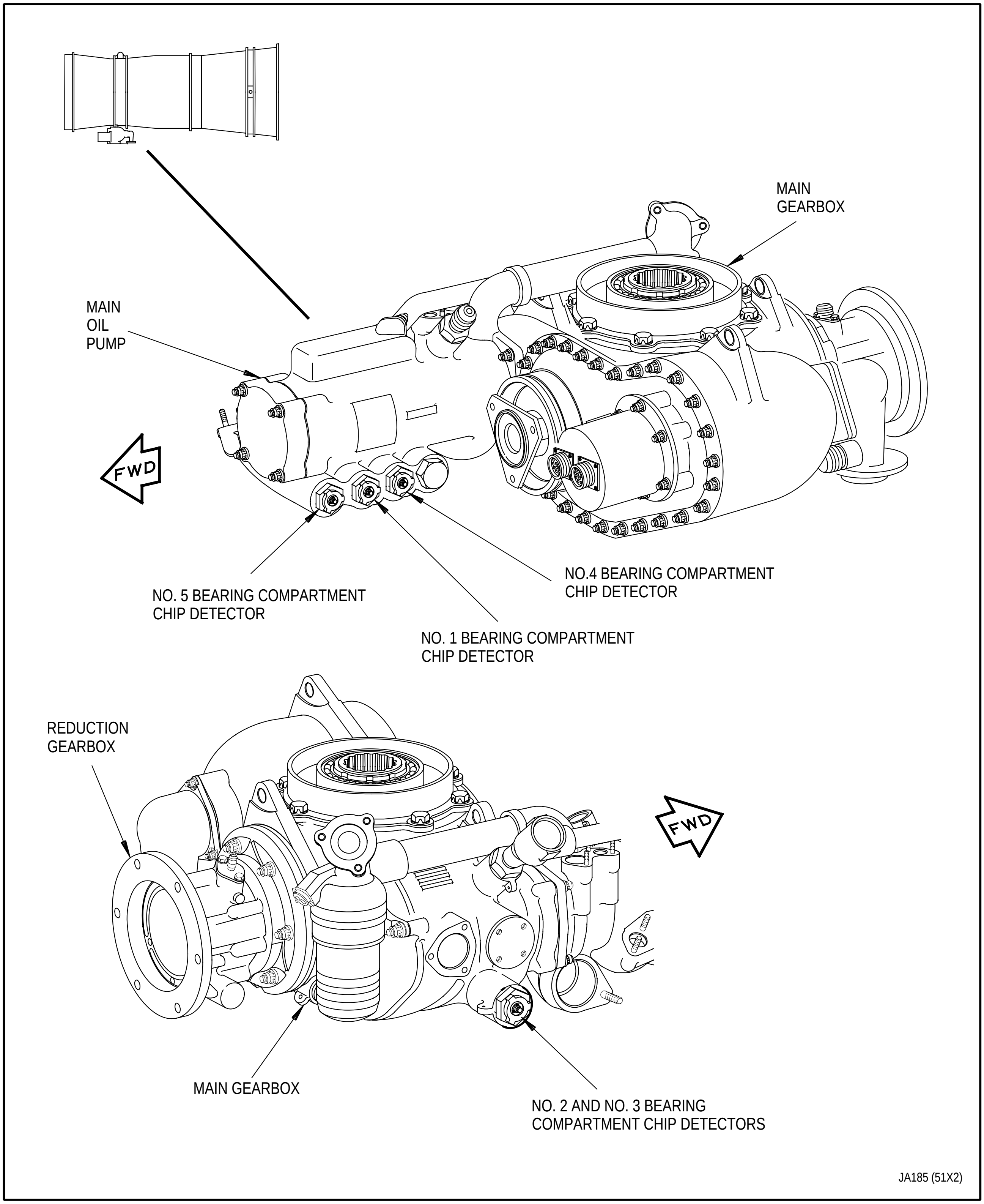


Figure 5. Chip Detectors

8. MAIN PUMP ASSEMBLY.

(See Figure 6.)

a. The main (oil) pump is mounted on the front of the engine gearbox.

(1) It is an assembly of six stages of positive displacement gear-type pumps. These gear pumps are:

- main pressure
- boost pressure
- No. 1, 4, and 5 bearing compartment scavenge pumps

(2) The No. 2 and 3 bearing compartment and gearbox are scavenged by a gear pump in the gearbox.

b. Bypass (relief) valves that operate at a preset pressure are provided for the main pressure and boost pressure stages.

c. The main bypass valve has bleed orifices that allow oil to bypass during normal operation by reducing pressure and flowrate.

d. The No. 1, 4, and 5 scavenge inlets and the boost inlet incorporate wire mesh strainers. The strainers catch and retain foreign objects to prevent ingestion, jamming of pump gears, and loss of engine oil pressure.

9. OIL PRESSURE SYSTEM.

a. The engine oil system is a self-contained nonregulated oil pressure system in that pressure varies with rear compressor rotor speed (N2), oil pump inlet oil temperature and oil quantity.

b. Oil is gravity supplied from oil tank to main pressure stage of the oil pump.

c. During cold weather starts, a relief valve at the main stage limits pump discharge pressure to a preselected value.

(1) The oil is directed through the full flow oil filter.

(2) The fuel oil cooler cools the oil prior to use on the bearings and gears.

d. Oil flows through the main oil pressure transmitter tap before it is delivered to the No. 2 and 3 bearing compartment and the engine gearbox.

e. A boost pump increases the main pump pressure to supply No. 1, 4, and 5 bearing compartments.

f. No. 1, 4, and 5 bearing compartments have a scavenge/ breather system which eliminates breather tubes.

(1) Breather pressure is higher than gearbox breather pressure in these compartments so boosted oil jet pressure is supplied by the booster pump.

(2) All oil jets are protected from clogging by in-line screen type last chance filters. They provide additional protection for the bearings and gears located in the oil pressure lines.

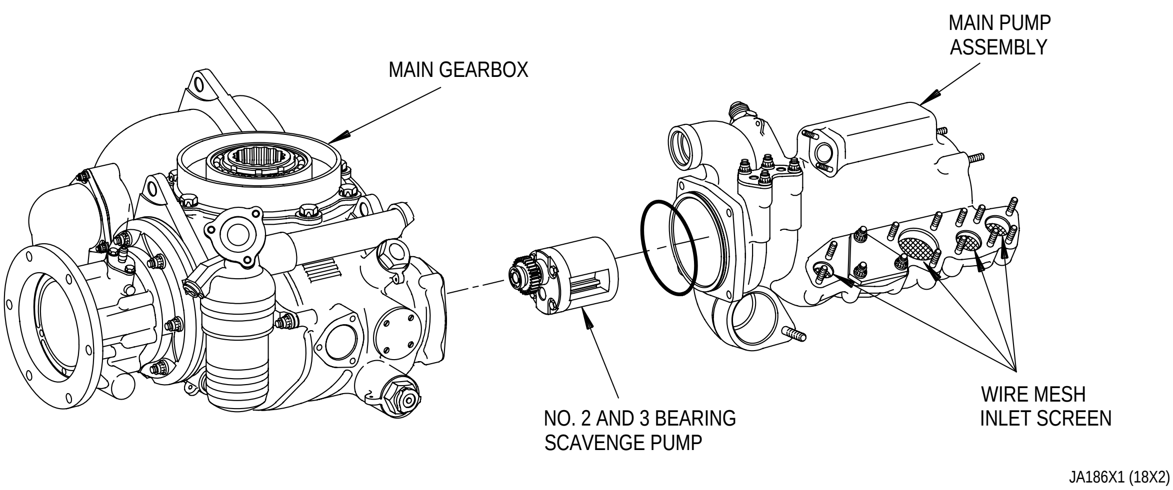


Figure 6. Main Pump Assembly and No. 2 and 3 Bearing Scavenge Pump Assembly

10. OIL SCAVENGE SYSTEM.

a. Oil is scavenged from the No. 1, 4 , and 5 bearing compartments by scavenge pumps that are part of the main oil pump assembly.

b. The No. 2 and 3 bearing compartment oil drains into the gearbox via the gearbox tower shaft cavity.

c. All scavenge pumps are connected to a common oil tank return line which discharges into the oil tank deaerator where the air is separated from the oil.

d. Main gearbox oil supply is also a source for reduction gearbox lubrication.

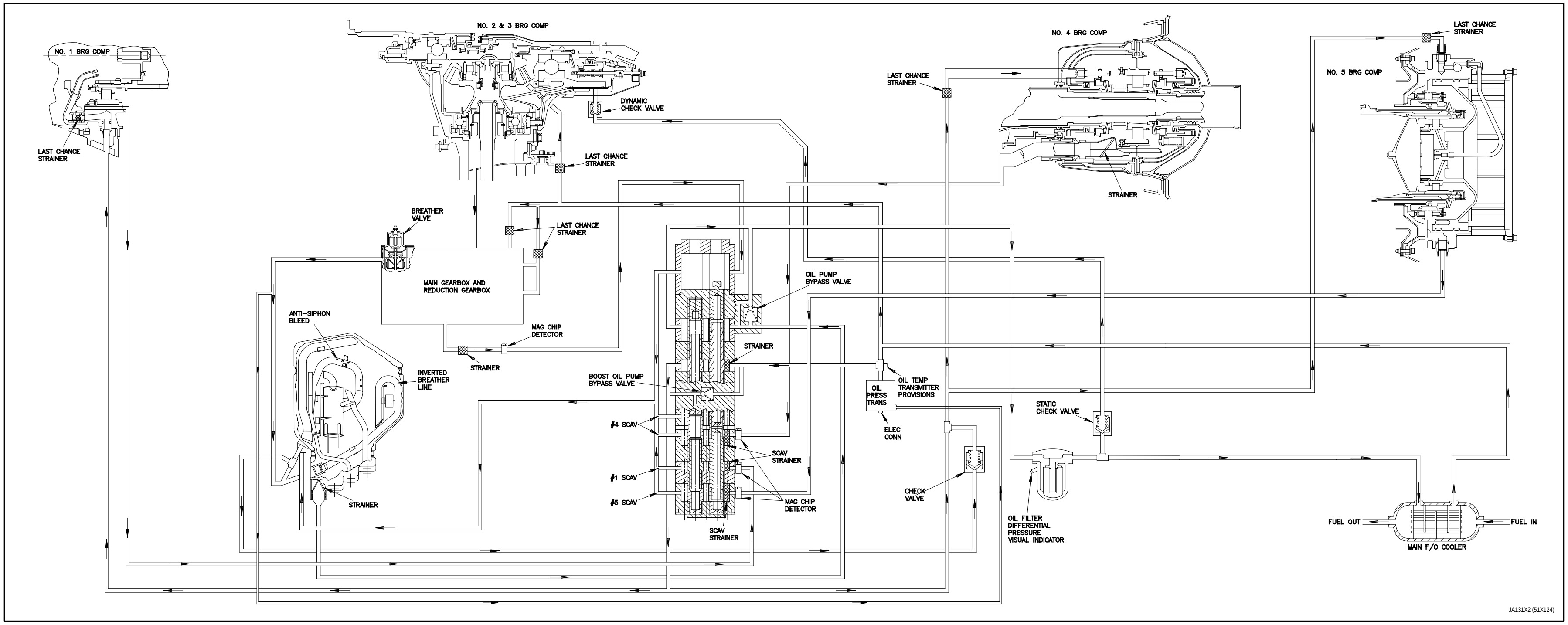
11. OIL BREATHER SYSTEM.

a. The No. 1, 4, and 5 bearing compartments are called capped compartments because they breathe through scavenge systems. In these compartments pressures are higher than in the gearbox.

b. The No. 2 and 3 bearing compartment is vented to the gearbox via the gearbox tower shaft cavity.

c. The oil tank is vented to the gearbox through an external line.

d. The system is vented to ambient (outside air) conditions through the breather pressurizing valve.



FO-1. Oil System Schematic

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION - COMPRESSOR INLET VARIABLE VANE ACTUATOR SYSTEM, REAR COMPRESSOR VARIABLE VANE ACTUATION SYSTEM, AND COMPRESSOR BLEED SYSTEM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 16

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	6	7 - 9	0	16 Blank	0
2 - 5	0	10	6		
6	6	11 - 15	0		

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes:

- Compressor inlet variable vane (CIVV) system
- Rear compressor variable vane system
- Compressor bleed system

2. COMPRESSOR INLET VARIABLE VANE ACTUATION SYSTEM.

(See Figure 1.)

a. The compressor inlet variable vane (CIVV) actuation system sets the operating angle of the variable compressor inlet guide vanes.

b. One CIVV control and cylinder and one CIVV cylinder positioning of the vanes by modulating fuel pressures (Pfext and Pfret) on the cylinder pistons and actuator rods.

c. The CIVV control and cylinder is mounted on the fan case left side at the 8 o’clock position. The CIVV cylinder is mounted on the fan case right side at the 2 o’clock position.

d. The cylinders are attached through bellcranks to a synchronizing ring that pivots the vanes in unison.

e. The DEEC electronically schedules the vane angle when the engine is operating in primary mode.

f. The vane angle is automatically scheduled to the camber position when the engine is operating in secondary mode.

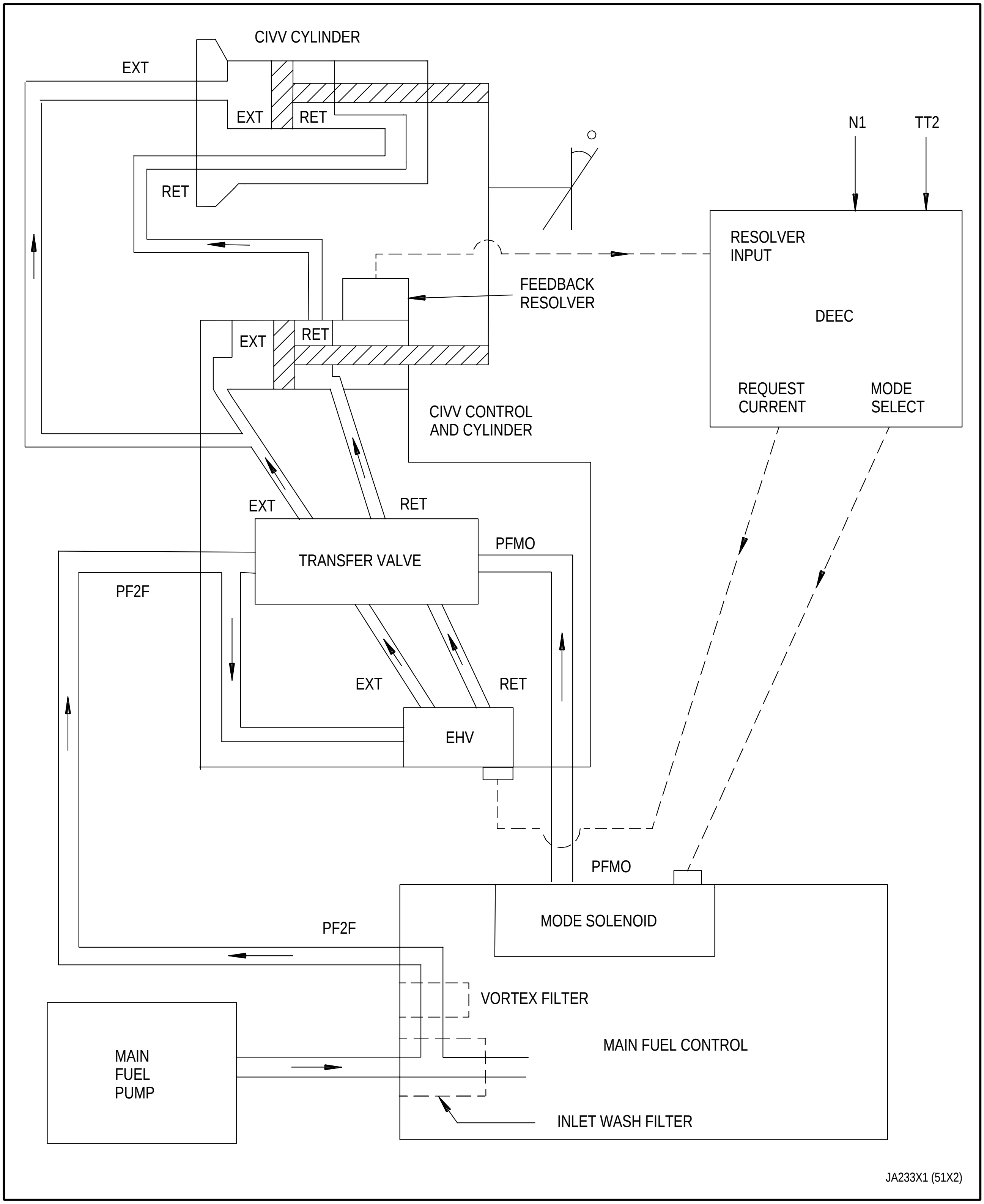


Figure 1. Compressor Inlet Variable Vane Linear Actuation System - Schematic

3. COMPRESSOR INLET VARIABLE VANE ACTUATION SYSTEM OPERATION. (See Figures 2 and 3.)

a. The CIVV actuation system, when in the primary operating mode, consists of:

- DEEC
- CIVV control and cylinder which contains a CIVV electro-hydraulic servo valve (EHSV), transfer valve, feedback resolver, and actuator
- CIVV cylinder

b. The DEEC controls vane angle position using engine parameters N1, and Tt2 to compute the optimum CIVV actuator position. Actual vane angle position is monitored and fed back to the DEEC by a CIVV control and cylinder mounted resolver.

c. The DEEC transmits a request current, which is proportional to the difference between the scheduled and actual vane angle postions, to the EHSV mounted on the CIVV control and cylinder. The EHSV creates two pressure signals, extend and retract, using vortex filtered fuel flow (Pf2f) from the main fuel control. The two pressure signals are ported through the integral transfer valve.

d. Upon transfer to the secondary mode, the transfer valve located within the CIVV control and cylinder slews to the backup position. Movement of the transfer valve is the result of a pressure signal (Pfmo) generated by the main fuel control mode solenoid. The DEEC actuates the mode solenoid for mode selection based on test stand or aircraft switch position. The DEEC can also automatically actuate the mode solenoid if its logic can no longer safely control the engine in primary mode.

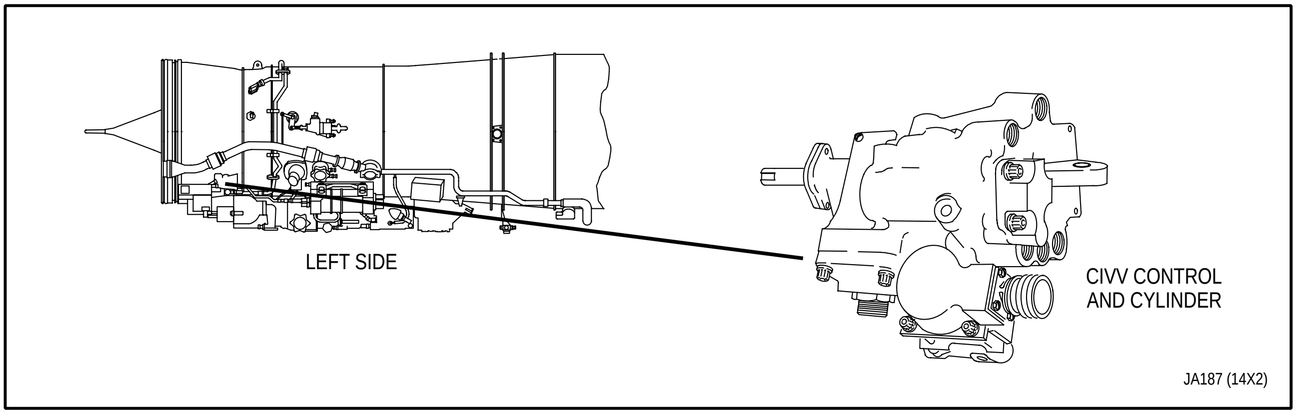


Figure 2. Compressor Inlet Variable Vane Control and Cylinder

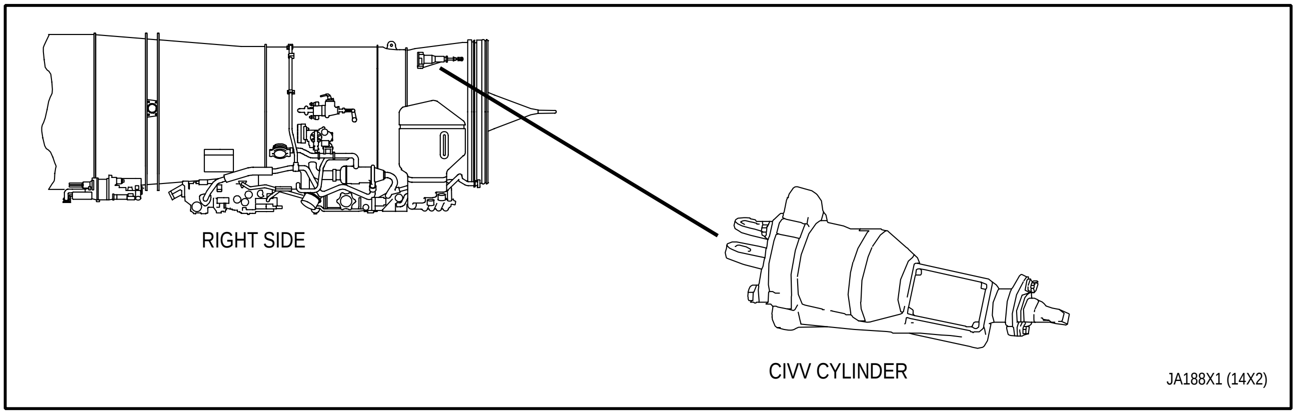


Figure 3. Compressor Inlet Variable Vane Cylinder

4. REAR COMPRESSOR VARIABLE VANE ACTUATION SYSTEM.
(See Figure 4.)

a. The RCVV actuation system monitors and sets the operating angle of the variable vanes in the rear compressor.

b. The RCVV cylinders control the position of the 4th, 5th, and 6th stage vanes. They are mounted at the 3 and 9 o’clock positions on the fan duct.

c. The actuators are connected by bellcranks to synchronizing rings which pivot the vanes in unison.

d. In primary mode the vane angle is electronically scheduled by the DEEC and hydraulically actuated by the main fuel control (MFC).

e. In secondary mode the vanes are scheduled and actuated hydromechanically.

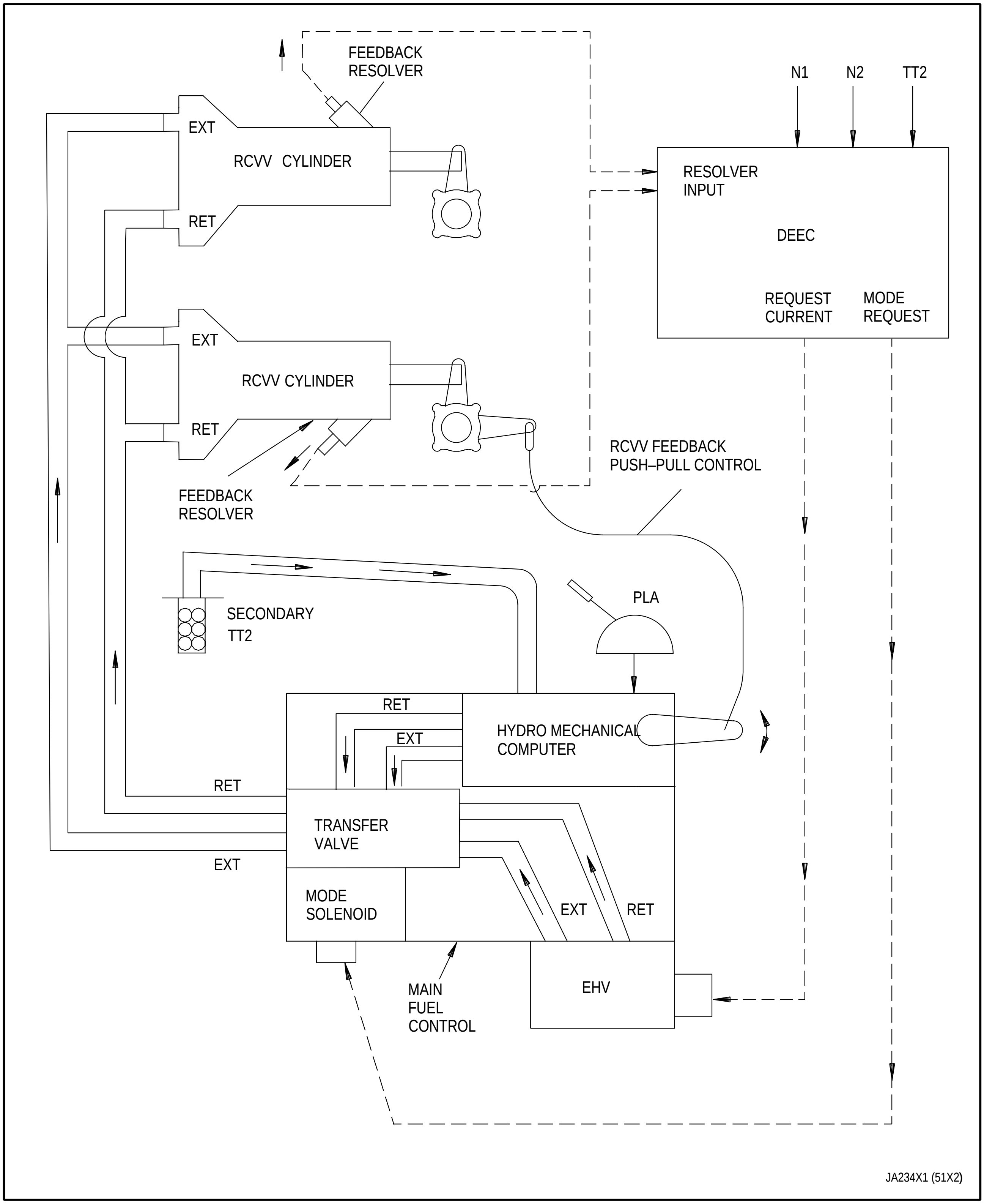


Figure 4. Rear Compressor Variable Vane Actuation System - Schematic

5. RCVV ACTUATION SYSTEM OPERATION. (See Figure 5.)

a. The RCVV actuation system, in primary mode, consists of:

- DEEC
- RCVV electro-hydraulic servo valve (EHSV) mounted on the main fuel control
- transfer valve located in the main fuel control
- two RCVV cylinders with integral resolvers

b. The DEEC controls vane angle position using engine parameters N1, N2, and Tt2 to compute the optimum RCVV cylinder position. Actual vane angle position is monitored and fed back to the DEEC by RCVV cylinder resolvers.

c. The DEEC transmits a request current, proportional to the difference between the optimum and actual vane angle position, to the electro-hydraulic servo valve (EHSV) mounted on the main fuel control. The EHSV creates a pressure signal, extend or retract. The pressure signals then are ported through a transfer valve in the main fuel control. The cylinders, in turn, extend or retract their actuator arms, thus changing vane angle position.

d. The RCVV actuation system, when in the secondary mode, consists of:

- hydromechanical computer in the main fuel control
- transfer valve located in the main fuel control
- two RCVV cylinders
- RCVV feedback push-pull control (mechanical feedback) cable

e. Upon transfer to the secondary mode, a hydromechanical computer in the main fuel control assumes scheduling and actuation responsibilities. The transfer valve slews to port the retract and extend signals to the RCVV cylinders.

f. The hydromechanical computer uses parameters PLA and Tt2 to calculate the RCVV cylinder position. Actual valve angle position is fed back to the main fuel control by the RCVV feedback push-pull control (cable), attached between the left rear compressor synchronizing arm and the main fuel control. The hydromechanical computer provides retract and extend pressure signals proportional to the difference between scheduled and actual vane angle positions.

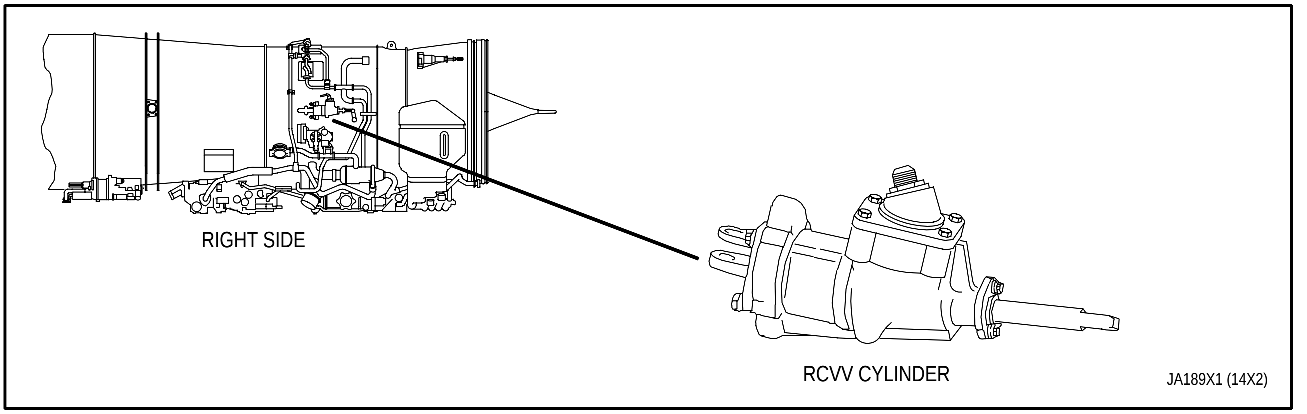


Figure 5. Rear Compressor Variable Vane Linear Actuating Cylinder

6. COMPRESSOR BLEED ACTUATION SYSTEM.
(See Figure 6.)

a. The compressor bleed actuation system provides for the opening and closing of the engine compressor bleed.

b. The DEEC electronically schedules the compressor bleed system when the engine is operating in primary mode.

c. The compressor bleed system is scheduled by a hydromechanical computer in the MFC during secondary mode operation.

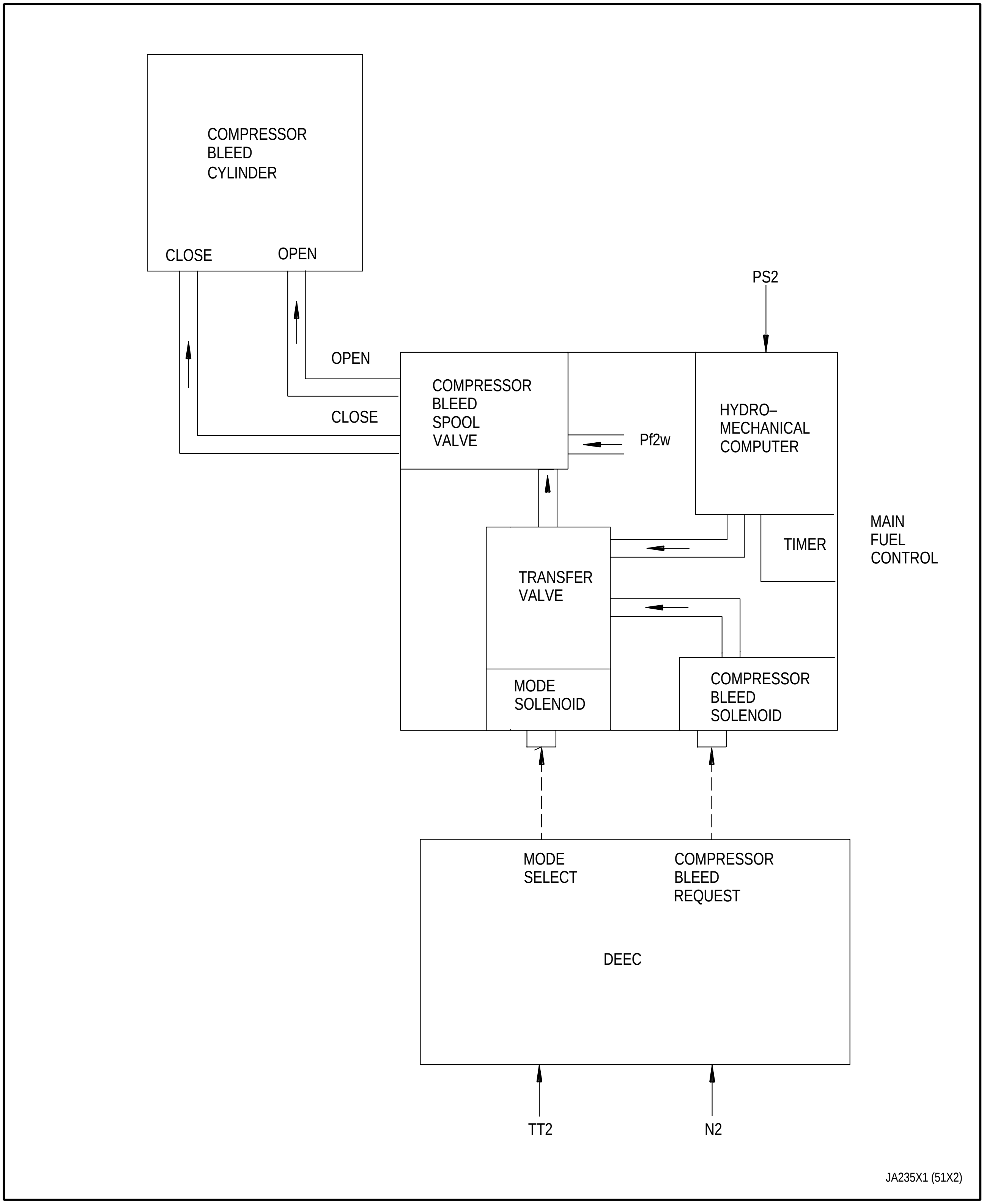


Figure 6. Compressor Bleed Actuation System - Schematic

7. COMPRESSOR BLEED ACTUATION SYSTEM.

(See Figure 7.)

a. The compressor bleed actuation system, when in the primary mode, consists of:

- DEEC
- compressor bleed solenoid, transfer valve, and compressor bleed spool valve, all housed within the main fuel control
- compressor bleed cylinder

b. The DEEC schedules the compressor bleed opened or closed using engine parameters N2 and Tt2.

c. The DEEC signals the compressor bleed solenoid which produces either a high or low pressure signal. The signal is ported through the transfer valve to position the compressor bleed spool valve. The spool valve then ports the pressure signal to the open or close ports of the compressor bleed linear cylinder.

d. In secondary mode the hydromechanical computer schedules the compressor bleeds opened or closed as a function of time (using its integral hydraulic timer) and Ps2.

e. During engine starts, the computer schedules the compressor bleed open until the hydraulic timer determines that the start time constraint has been met. The compressor bleed is then scheduled closed. The hydromechanical computer opens and closes the compressor bleed by porting a pressure signal through the transfer valve to the compressor bleed spool valve. The spool valve ports the appropriate high pressure signals to the open or close port of the compressor bleed cylinder.

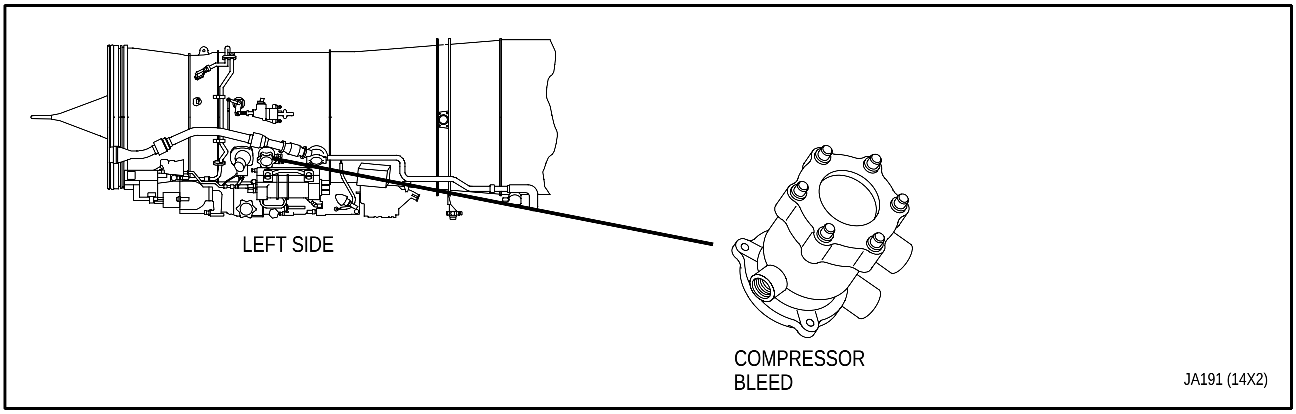


Figure 7. Compressor Bleed Cylinder

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

ANTI-ICING SYSTEM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the engine anti-icing system.

2. ANTI-ICING SYSTEM.

a. System Operation (See Figure 1.)

(1) The anti-ice valve is controlled by a combination of electrical signals from the aircraft cockpit (24 VDC) and the DEEC (14 vdc). The dual solenoid actuated valve will close (anti-ice inhibited) when either or both solenoids receive electrical power. To open the valve (allowing anti-ice), both solenoids shall be deenergized.

(a) The DEEC will allow anti-ice operation if:

- Altitude is less than 30,000 ft (Ps2)
- 13th-stage air temperature is greater than 750°F (399°C) (function of PLA and Tt2)
- Engine inlet temperature is greater than 60°F (15°C)

(b) The aircraft will allow anti-ice operation if:

- Anti-ice switch is in the on position
- Anti-ice switch is in the auto position and the aircraft ice detection logic system detects ice is forming in the aircraft intake

(2) Once the valve opens the manifold directs the hot air into the inlet case. From there the air is directed through the inlet struts where some of the air is bled to provide a boundary layer of air across the CIVVs. The air not bled from the strut is directed into the nose cone where it exits through slots into the engine inlet airstream.

(3) A thermocouple, connected to the anti-ice manifold downstream of the anti-ice valve, provides a 13th-stage air temperature signal to the EDU.

(4) The DEEC will perform a ground check 30 seconds after the engine reaches idle speed to check anti-ice valve operation. If the cockpit anti-ice request is on, the DEEC cycles the anti-ice valve open then closed. The EDU will check for proper operation (valve failed open or closed).

3. ANTI-ICING VALVE.
(See Figure 2.)

a. The engine mounted anti-icing valve is dual solenoid actuated and spring loaded to the open position. It remains open during the engine start sequence.

b. When compressor 13th stage bleed air reaches 20 psi, the valve closes and remains closed until:

- engine operator selects the anti-icing ON position of the external switch and
- the DEEC internal signal to the anti-icing valve requests the ON mode or
- engine 13th stage bleed air dips below 20 psi at the anti-icing valve or
- there is a total electrical power failure to the valve

c. Under normal operating conditions (anti-ice not required), the valve will close before the engine reaches idle thrust.

d. The DEEC decision to activate anti-icing is based on altitude, Tt2, and PLA schedules.

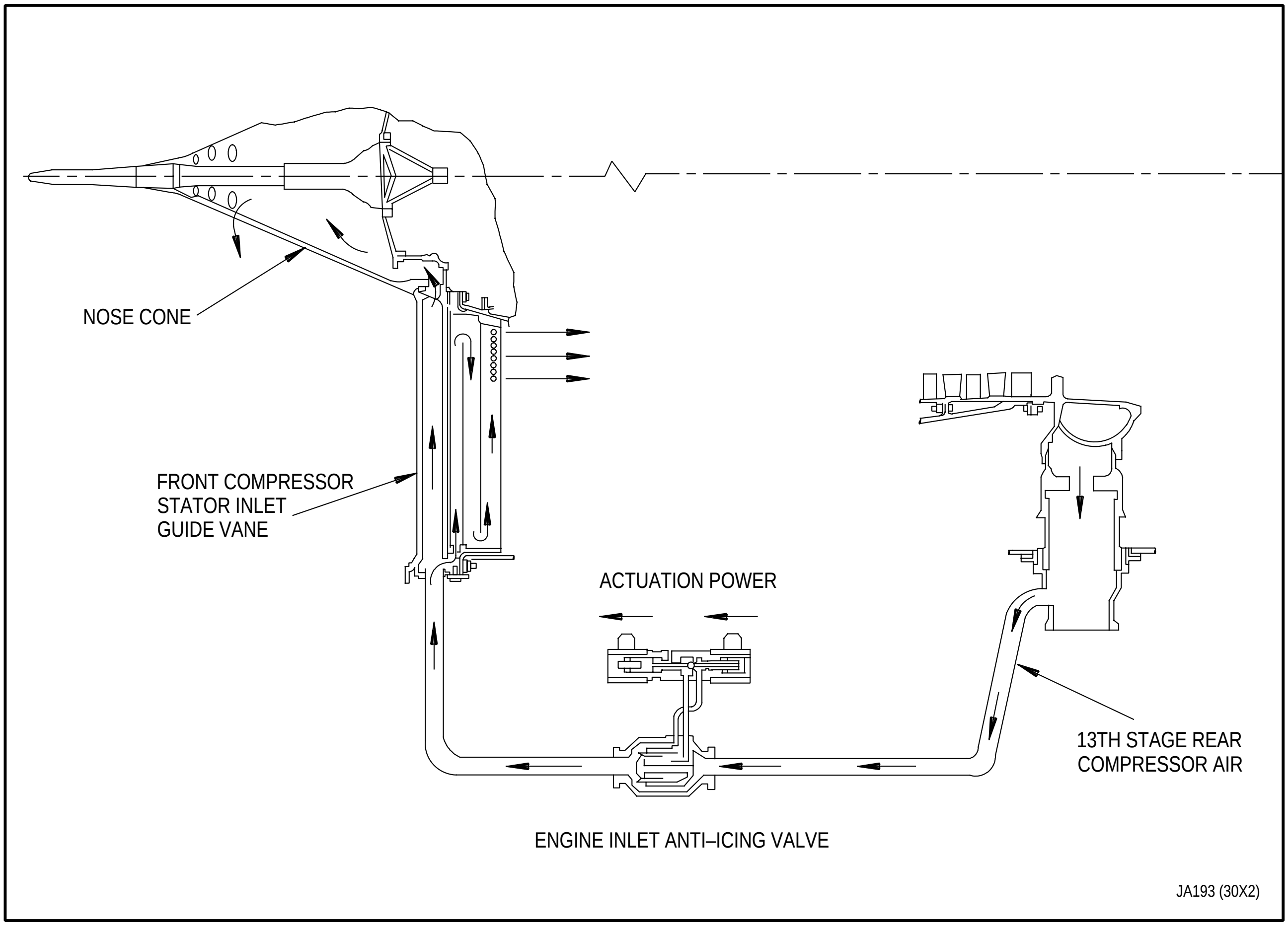


Figure 1. Anti-icing System Schematic

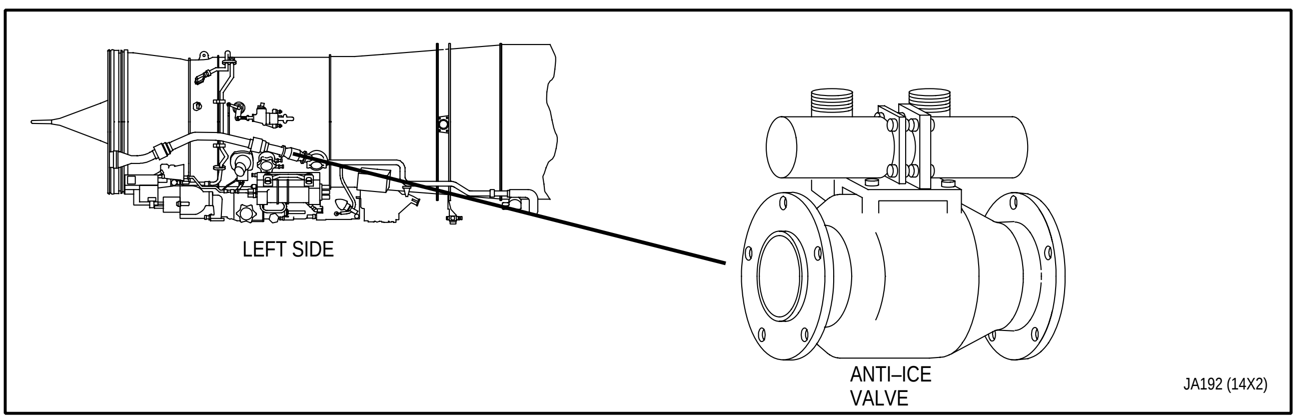


Figure 2. Anti-ice Valve

WORK PACKAGE

GENERAL ENGINE AND SYSTEMS DESCRIPTION -

AUGMENTOR NOZZLE ACTUATION SYSTEM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
General Engine and System Description - Augmentor Duct and Nozzle Module - - - - - - - - - - - - - - -	WP 011 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package describes the augmentor nozzle actuation system.

2. AUGMENTOR NOZZLE ACTUATION SYSTEM.

a. The augmentor nozzle actuation system consists of a multiple segment, convergent-divergent, pneumatically (air) actuated nozzle. Refer to T.O. 2J-F100-53-1, WP 011 00.

b. The balance and convergent segments form a balance beam convergent nozzle that requires very little actuation to be changed from minimum to maximum area.

(1) The convergent nozzle is adjusted by an air motor and five equally spaced ball screw actuators.

(2) These actuators position the nozzle throat (convergent area) through a system of bellcranks and links mounted very near the throat on the back or outer side of the convergent nozzle segments.

(3) The convergent exhaust nozzle control (CENC) varies the nozzle area as required to control engine airflow and rotor speed.

c. The divergent nozzle is a free floating system. It has no mechanical actuation.

(1) The system consists of:

- connecting links
- divergent nozzle segments and seals

(2) The operating mode or position of the divergent nozzle depends entirely upon:

- exhaust gas pressure and ambient (outside) air pressure on the divergent nozzle segments

d. The augmentor nozzle actuation system components include:

- convergent exhaust nozzle control
- flexible drive cables

3. CONVERGENT EXHAUST NOZZLE CONTROL.
(See Figure 1.)

a. The convergent exhaust nozzle control (CENC) provides the power to position the exhaust nozzle. The CENC drives five ball screw actuators which move the convergent segments of the nozzle. The CENC responds to DEEC signals in primary and main fuel control (MFC) signal pressure (Pfmo) in secondary mode.

b. The CENC consists of:

- electro hydraulic servo valve
- hydraulic input section
- mixing transmission
- bidirectional air control valve
- reversible air motor
- resolver

c. The DEEC signals the electrohydraulic servo valve (EHSV) which provides fuel pressure to drive a piston in the hydraulic section. Through a mixing transmission the piston drives a DEEC feedback resolver and an air control valve.

d. The DEEC supplies null current to the EHSV as long as the feedback resolver position equals the requested position. If it is not equal, the DEEC changes its EHSV signal, and fuel pressure moves the piston until the DEEC feedback resolver equals the DEEC request.

e. The piston also opens the air control valve directing 13th stage compressor air to the air motor.

f. The air motor drives the actuators through flexible driveshafts. The shafts rotate actuators which adjust the nozzle in direct proportion to the change in resolver position.

g. The hydraulic section incorporates a transfer valve (actually Pfmo) which transfers the CENC to secondary mode. In secondary mode the MFC sends a high pressure signal to the CENC. The transfer valve shuts down the EHSV circuit and pressurizes the piston. The piston activates the air motor to close the nozzle. The CENC will also transfer to secondary mode upon the loss of the DEEC signal to the EHSV.

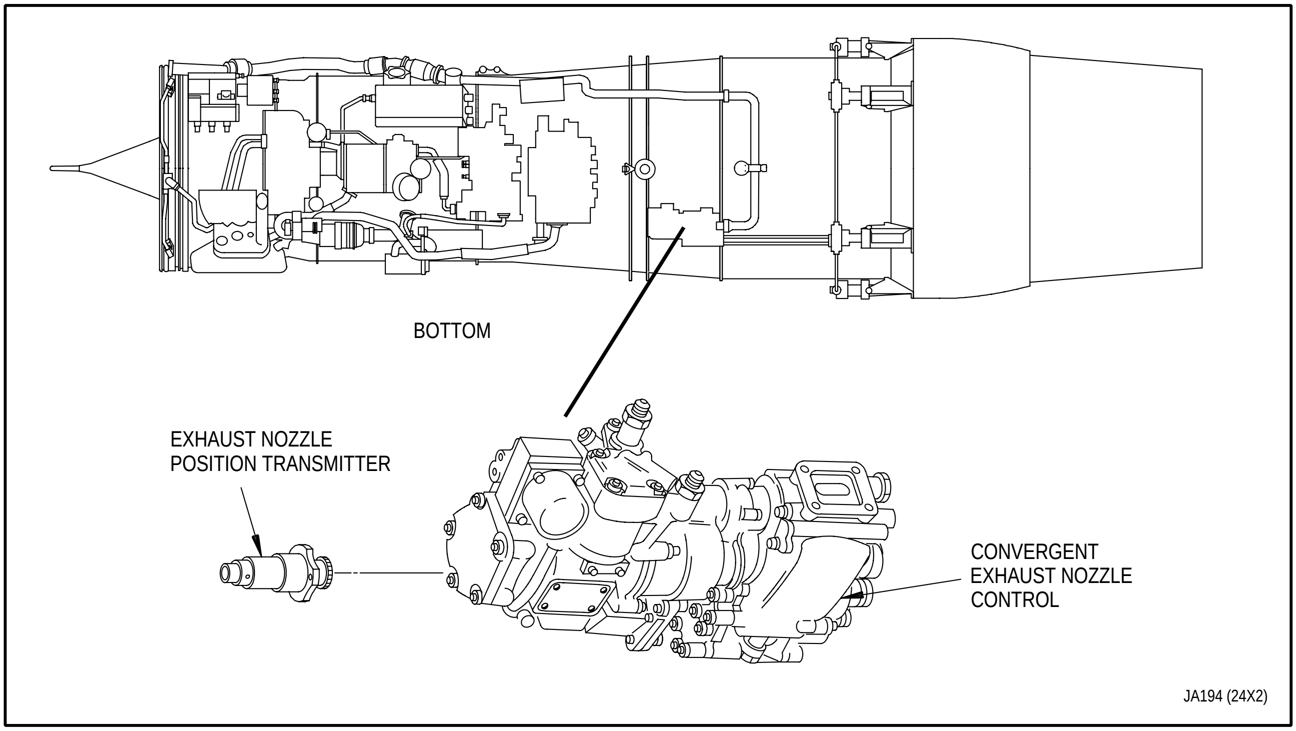


Figure 1. Convergent Exhaust Nozzle Control

4. FLEXIBLE SHAFTS.

a. The flexible shafts consist of five cables enclosed in tubing that couple and synchronize the five convergent nozzle ball screw actuators.

b. Two redundant flexible shaft cables, also enclosed in tubing, connect the output of the convergent exhaust nozzle control to the right angle transfer box of the primary ball screw actuator.

WORK PACKAGE

INTRODUCTION

GENERAL PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 2

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	17				

1. INTRODUCTION.

a. This work package introduces the 020 00 through 029 00 series of work packages for the introduction and general information manual. The following work packages/ subordinate work packages are included in this series:

WP/SWP No.	Title
021 00	General Procedures - Depot Maintenance Procedures
022 00	General Procedures - Antifriction Bearings, General Handling, Removal and Installation
023 00	General Procedures - Marking, General
023 01	General Procedures - Marking, Temporary
023 02	General Procedures - Marking, Electrochemical (SPOP 401)
024 00	General Procedures - Vacuum Leak Check Using PWA 50003 Carbon Seal Tester
024 01	General Procedures - Vacuum Leak Check Using Habco 1543003 Vacuum Air Flow Cart
025 00	General Procedures - Airflow Check Using PWA 50047 Pneumatic Test Set
025 01	General Procedures - Airflow Check Using Habco 1093005 Portable Air Flow Checker
026 00	General Procedures - Oil Nozzle Assembly, Air or Visual Flow Check
027 00 through 029 00	Open

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES -

DEPOT MAINTENANCE PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 32

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	23	8	20	18	23
3 - 7	0	9 - 17	0	19 - 32	0

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Antifriction Bearings, General Handling, Removal and Installation	WP 022 00
Marking, General	WP 023 00
Feature Control Symbols	WP 091 00
Plating, Cadmium (SPOP 21)	SWP 092 05
Plating, Silver, on Steel (Not Stainless) (SPOP 23)	SWP 092 07
Plating, Silver, on Stainless Steel or Nickel (SPOP 24)	SWP 092 08
Compounds, Application, General	WP 098 00
Compound, Antigalling (PWA 550) Application (SPOP 156)	SWP 098 03
Compound, Antigalling (PWA 474) Application to Steelor Titanium Parts (SPOP 160)	SWP 098 04
Compound, Antigalling and Corrosion Preventive (PWA 559) Application (SPOP 161)	SWP 098 05
Compound, Antigalling (PWA 36545) Application (SPOP 748)	SWP 098 07

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cloth, crocus	P-C-458
Compound, antigalling	Everlube 382
Compound, sealing, aluminum putty	Devcon F
Lubricant, dry film	Fel-Pro C-300
Lubricant, gear lube SAE 250	Kendall All-Oil
Lubricant, engine oil (PWA 36500)	Ultrachem Assembly Fluid No. 1
Nitric acid	O-N-350

CONSUMABLE MATERIALS (continued)

Nomenclature	Specification/Vendor Part Number
Lockwire (0.032 inch diameter)	MS9226-04
Lockwire (0.040 inch diameter)	MS9226-05
Oil, lubricating	MIL-L-7808
Oil, lubricating	MIL-L-6081, Grade 1010
Petrolatum	VV-P-236
Solvent, petroleum	P-D-680, Type II

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Tool Nomenclature	Tool Number
16	Metal Seal Rings - Installation	
	Pliers -	PWA 53778

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for the following general procedures:

- Disassembly
- Assembly
- Application of compounds
- Installation of ball and roller bearings
- Gaskets, packings, and rubber parts
- Bolt, locknut, and key washer effective locking
- Identification of hardware material
- Marking of parts
- Lockwiring
- Tubing installation
- Electrical cables - torque procedures
- Metal seal rings - installation
- J-threads features identification
- Lubrication of rubber preformed packings
- Removal, inspection, repair, and installation of bushings and ring liners
- Replacement, lubrication, and torquing of studs
- Inspection of universal fittings
- Torque check for reuse of self-locking fasteners
- Shear-fitting of silver plated splines
- Feature control symbols

2. GENERAL DISASSEMBLY PRACTICES.

a. Disassembly instructions are written with the understanding that the following will be removed when necessary before attempting to disassemble any part of engine.

- Lockwiring
- Cotter pins
- Nut
- Key washers
- Washers
- Bolts
- Screws

b. When separating engine sections, it is permissible to use electrical or air driven hoists.

c. Use care whenever hoists of any kind are used to preclude damage to engine bearings or related parts.

d. When breaking torque on any tube coupling nut, ensure counter-torque is applied with suitable wrench to part from which tube is being removed. Countertorque when properly applied will prevent bending or damage to parts.

e. Examine engine parts, during various stages of disassembly, for signs of scoring, burning, or any other evident damage.

f. Note physical conditions which may not be apparent until after cleaning.

g. Tag parts before they are cleaned or laid out for detail inspection.

h. Look for indications of work incorrectly performed during previous repair.

i. Report any findings per current practice.

j. Immediately upon removing an assembly or individual part from engine, transfer it to part rack or arrange it to protect from damage.

k. In handling assemblies, provide proper covering or support to protect shafts, gears, studs, or any projecting part from being bent, scratched, or otherwise damaged.

l. Lift heavy parts with proper lifting fixture and hoist to prevent damage to parts or physical harm.

m. Bearings require special care to prevent corrosion or contamination.

n. Use care in handling and disposition of bearing as follows:

(1) Wear clean gloves.

(2) Wrap in clean moisture-proof paper.

(3) Seal in plastic bags.

o. Destroy all removed packings.

p. Keep all engine parts clean and protected from corrosion.

q. External tube assemblies.

(1) Remove loose ferrule and nuts from each tube prior to cleaning and inspection.

(2) Do not bend tube during disassembly of parts.

(3) Use suitable plugs and coverings on all openings where tubes have been removed or disconnected.

(4) Use caution to prevent dust or foreign matter from entering connecting component.

r. External components.

(1) If any component or accessory is removed from engine, cap open tubes to prevent contamination.

s. Pneumatic wrenches (Black and Decker, FSCM 81365, model numbers 2430 and 2433, or equivalent) may be used to remove nuts and bolts connecting engine case flanges. These wrenches have been authorized for disassembly only.

3. GENERAL ASSEMBLY PRACTICES.

a. Assembly instructions are written with the understanding that the following will be accomplished or adhered to.

- Torque
- Tolerance
- Calibration limits
- Dimension check
- Lockwiring
- Covering of engine opening

b. Use care whenever hoists of any kind are used to preclude damage to engine bearings or related parts.

c. To avoid unnecessary repetition in detailed assembly instructions, certain general assembly methods and procedures are described in T.O. 2-1-111. These items play an important part in efficient engine overhaul, and the ultimate life and performance of the engine can be seriously affected if they are slighted through carelessness or neglect.

d. Keep assembly area clean.

e. Keep floor and benches free of loose dust and dirt.

f. Keep all engine openings covered with protective cover or plates during the assembly.

g. Guard against plugging of oil jets, tubing and passage by maintaining cleanness during assembly.

h. Seal the ends of all tubes with plastic or metal caps until they are ready to be used.

i. Use care to prevent washers, nuts, bolts or small pieces of lockwire from dropping into the engine. If any loose piece is dropped, do not proceed with assembly, until the piece is located and removed.

j. Tools should never be left resting on any part of the engine, for they may be left and forgotten inside during assembly.

k. Always lay tools down on workbench.

l. If parts are coated with corrosion preventive compound, remove all traces of this compound and accumulated foreign matter.

m. During assembly it is highly desirable to have all parts for a specific engine reassembled into the original configuration and reinstalled in the same module or engine. Although it may be necessary to interchange assemblies and parts from one engine or module to another, an engine or module shall not be down graded by interchanging, substituting or intermixing of assemblies or parts. Keeping a maximum number of original assemblies and detailed parts together will result in saving of assembly and calibration time.

n. Frequent reference to the Table of Limits work packages shall be made if required to supplement text during all operations which involve measurement or use of gages.

4. APPLICATION OF COMPOUNDS.

a. Refer to T.O. 2J-F100-53-1, WP 098 00.

5. INSTALLATION OF BALL AND ROLLER BEARINGS.

a. Refer to T.O. 2J-F100-53-1, WP 022 00.

6. GASKETS, PACKINGS, AND RUBBER PARTS.

a. Unless otherwise specified, lubricate synthetic rubber packings with MIL-L-7808 oil or VV-P236 petrolatum.

CAUTION

Failure to use specified lubricant may cause fuel system rubber packings and seals to swell.

b. When installing fuel system components, apply thin film of VV-P-236 petrolatum to any synthetic rubber packings or seals used. This application should facilitate installation and eliminate scuffing of packing material.

7. BOLT, LOCKNUT, AND KEY WASHER EFFECTIVE LOCKING.

a. Refer to T.O. 2-1-111.

8. FITTINGS.

a. Refer to T.O. 2-1-111.

9. IDENTIFICATION OF HARDWARE MATERIAL.

a. Refer to T.O. 2-1-111.

10. MARKING OF PARTS.

a. Refer to T.O. 2J-F100-53-1, WP 023 00.

11. LOCKWIRING.

NOTE

Manufacturer may have used safety cable instead of lockwire in some locations on various controls. Safety cable is an optional fastener retention system and may be replaced with prescribed lockwire during component repair.

a. Refer to T.O. 2-1-111. Unless otherwise specified, lockwire PN MS9226-04 (0.032 inch diameter) and PN MS9226-05 (0.040 inch diameter) may be used as a suitable substitute for each other.

12. TUBING INSTALLATION.

(See Figures 1 through 4.)

a. General.

(1) Route tube assembly between attaching point without imposing any bending or twisting stresses.

(2) Lubricate tube nut with proper lubricant specified in text or key to figure. Loosely thread coupling nuts and ensure tube is not bent or misaligned.

CAUTION

Clamp installation must not impose stresses on tube assembly. If adverse stresses on tube are encountered, support clips may require repositioning.

(3) Position and secure tube support clamps at proper locations. Installed tube clamps must not slip or rotate freely. If clamp does not meet these requirements, replace clamp.

(4) Make sure additional wrench is used as countertorque when tightening or loosening tube coupling nuts. Torque tube coupling nuts and check to ensure no twisting stresses occur to tube. (See figure 1.)

(5) Use holding wrench to prevent rotation of adapters when tightening or loosening tubing nuts, as shown in figure 1.

(6) Where conical gaskets are required, carefully mate female cone of gasket to male cone of adapter, as shown in figure 2.

(7) Where installation of angle gaskets is required, install gasket with angle toward female flange as shown in figure 3.

(8) Lockwire tube fittings to adjacent or mating fittings.

CAUTION

For fittings not incorporating wire lugs, use caution to ensure that wire is wrapped tightly around fitting and not around tubing, to prevent tube wear.

(9) Attach lockwire securing tube fitting to adjacent or mating fittings. See figure 4 and T.O. 2-1-111 for specific examples of typical lockwiring.

(10) Where installation of angle gaskets is required, install gasket with angle toward female flange as shown in figure 3.

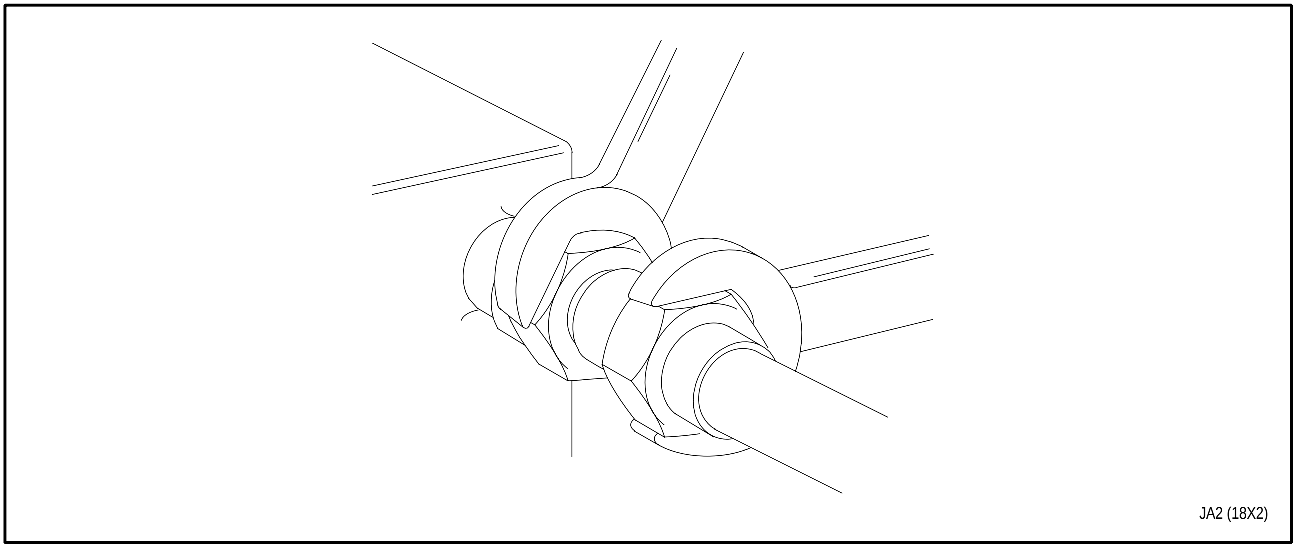


Figure 1. Typical Holding Wrench Use

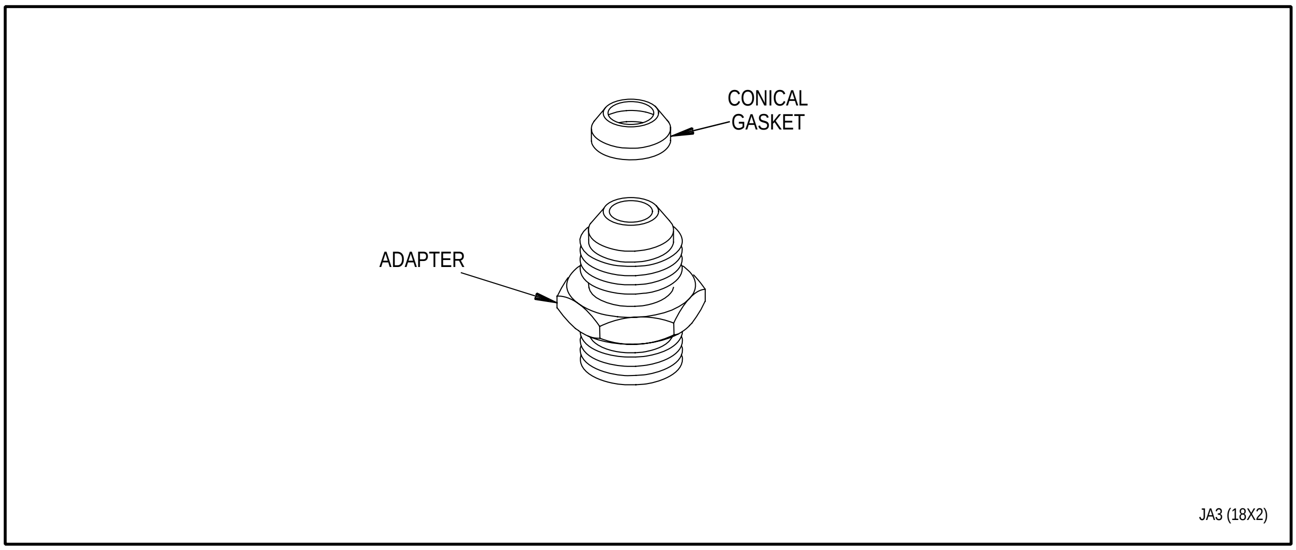


Figure 2. Mating of Conical Gasket to Adapter

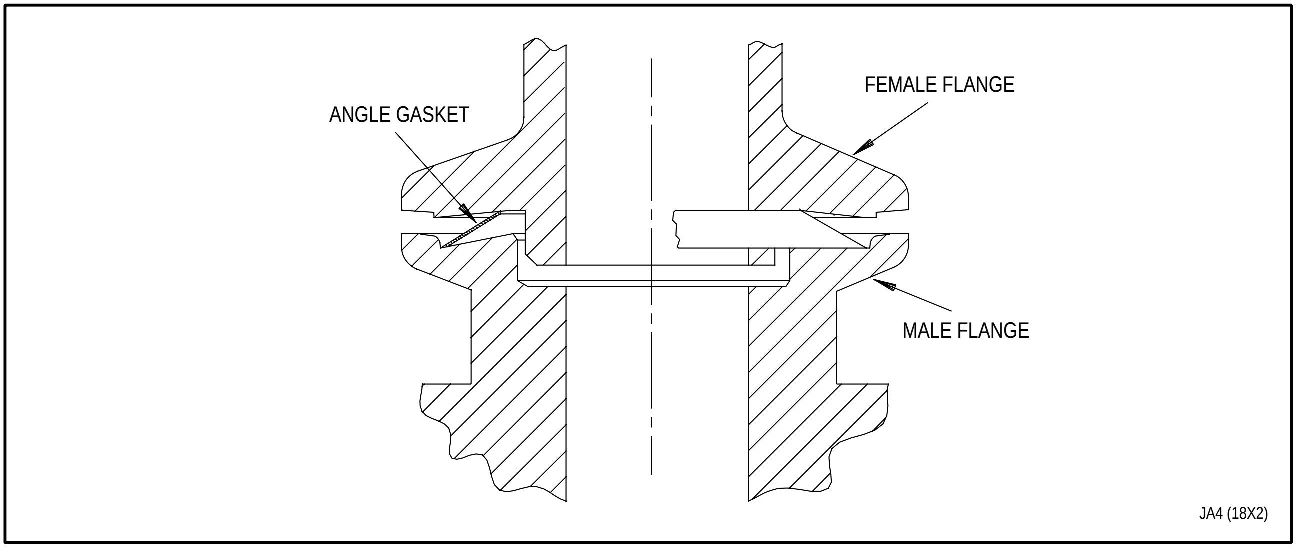


Figure 3. Typical Installation of Angle Gasket

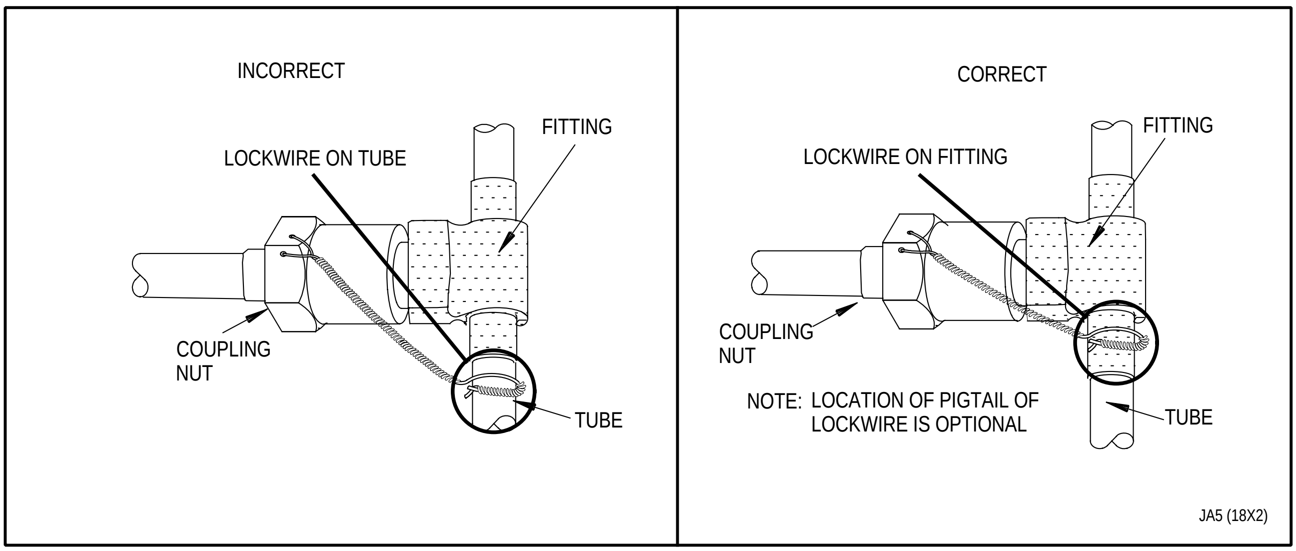


Figure 4. Typical Correct Lockwiring of Tube Fittings

(11) Lockwire tube fittings to adjacent or mating fittings.

b. Tube and manifold clearances.

NOTE

A supported section is that portion of tubing which extends 6 inches on either side of clamp or 6 inches from a fixed end fitting.

(1) A minimum clearance of 0.030 inch is required between the supported section of a tube or manifold assembly and any adjacent tube, manifold or structure.

(2) A minimum clearance of 0.090 inch is required between the supported section of any tube or manifold assembly and any operating mechanism.

(3) A minimum clearance of 0.090 inch is required between the unsupported section of any tube or manifold assembly and any adjacent tube, manifold or structure.

(4) A minimum clearance of 0.120 inch is required between the unsupported section of any tube or manifold assembly and any operating mechanism.

(5) Visual evidence of chafing between tube or manifold assemblies and other adjacent parts is not acceptable.

13. TUBING REPOSITIONING.

CAUTION

Do not bend tubes, or unacceptable clearances or damage may result.

a. Reposition tubes and manifolds that are under clearance limits using the following procedure.

(1) Check for bent brackets, unsecured or loose clamps, improperly torqued tube nuts, bent tubes or any other situation that may cause unacceptable clearance.

(a) Reposition or tighten clamps, retorque tube nuts and replace parts as necessary.

(2) If clearance is still under limits reposition complete tube as follows:

(a) Loosen tube nuts and all supporting clamps.

(b) Check conical gaskets and replace if necessary.

(c) Reposition tube in direction required to obtain proper clearance limit.

(d) While holding tube in position, retorque tube nuts and secure clamps.

14. ELECTRICAL CABLES.

a. General installation procedures and clearances.

(1) Cables shall be supported to prevent chafing and interference between other cables and tube assemblies. It is acceptable for cables to contact other surfaces under hand pressure provided that they spring back a minimum of 0.030 from the surface when the pressure is removed.

(2) Visual evidence of chafing between cable and other adjacent parts is not acceptable.

b. The following torque procedure shall be accomplished without use of wrench. Use hand pressure only. Torque procedure applies to all electrical connectors except exciter-to-igniter leads and P7 and P8 connectors at oil pressure transmitter and exhaust nozzle position transmitter. For these exceptions refer to applicable installation work packages/subordinate work packages.

(1) Align the master key (widest) and keyway and engage mating connectors.

(2) Handtighten connector knurled ring, while maintaining inward pressure on connector backshell.

(3) When knurled ring is tight, confirm bottoming of connector and tightness of connection by shaking cable and connector backshell. There shall be no relative motion between the backshell and connector knurled ring.

(4) Lockwire using PN MS9226-03 lockwire.

15. ELECTRICAL CONNECTOR - RECEPTACLE INSPECTION AND REPAIR.

(See Figure 5.)

NOTE

The terms electrical connector and electrical receptacle are used interchangeably.

a. Visually inspect electrical connectors for bent pins. Slightly bent pins may be straightened per step b. Replace connector module or component if pins are more than slightly bent, have multiple bends, are cracked (before or after straightening), or are missing.

CAUTION

Needle nose pliers can damage pin plating. Protect pins with plastic sheath if needle nose pliers are used.

b. Use needle nose pliers, mating socket, or small ID tubing to straighten pins. (See figure 5.)

c. Visually inspect connector threads. Replace module or component if threads are stripped, crossed, or missing.

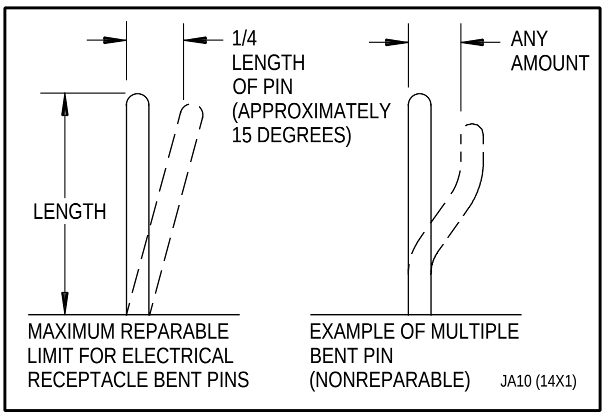


Figure 5. Electrical Receptacle Bent Pin - Repair

16. METAL SEAL RINGS - INSTALLATION. (See Figures 6 and 7.)

a. Several precautions shall be taken during assembly of parts containing metal seal rings (piston rings) to avoid potential damage to rings or grooves.

(1) Clean rings and grooves.

(2) Check fit between metal seal rings and grooves prior to installation by rolling OD of ring around perimeter of grooves. Hand file or stone groove surfaces to remove nicks or burrs. Smooth sides of rings with appropriate abrasive cloth to promote freedom in groove.

b. Install metal seal rings as follows:

CAUTION

PWA 53778 pliers shall be used when installing rings. If rings are opened more than necessary they may become overstressed and permanently distorted and not conform to mating part after installation.

(1) Install metal seal rings in grooves using PWA 53778 pliers. (See figure 6.) Maximum gap should not exceed eight times ring wall. (See figure 7.)

(2) Lubricate rings with petrolatum.

(3) When possible, assemble with mating parts using appropriate ring compressor.

(4) Place gap of ring 180 degrees from gap of an adjacent ring.

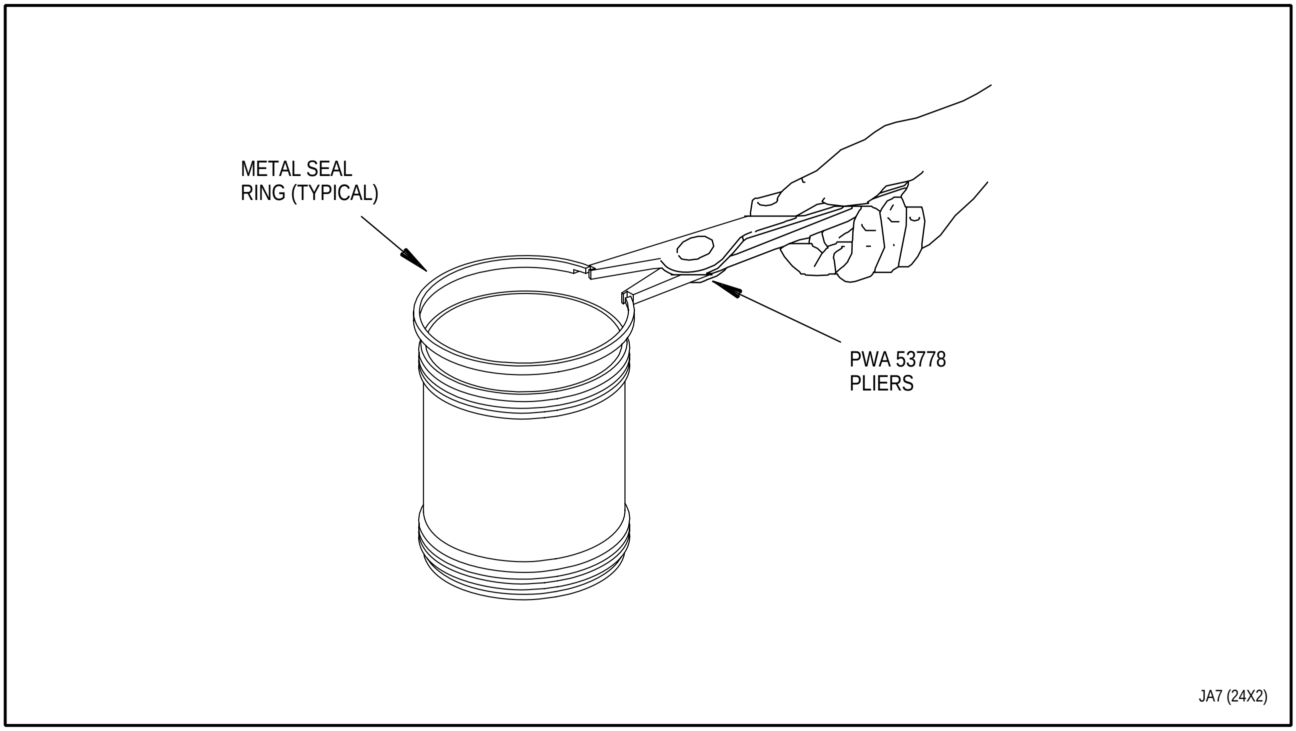


Figure 6. Typical Use of PWA 53778 Pliers When Installing Metal Seal Rings

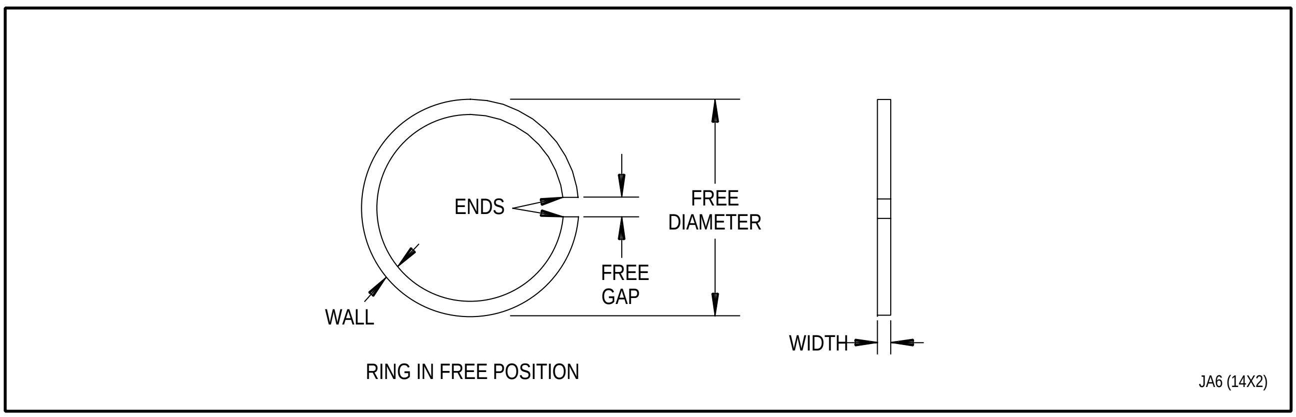


Figure 7. Typical Metal Seal Ring

17. FEATURES OF J-THREADS MIL-S-8879.

a. J-thread form features full rest radius for external threads with increased minor internal thread diameter.

b. J-threads ensure following:

(1) Greater fatigue life.

(2) Improved stress relaxation characteristic.

(3) Improved tensile strength or previous design.

c. J-thread form is used extensively.

d. Illustrated Parts Breakdown designates J-threaded parts as UNJC, United National Coarse (J-Thread) or UNJF, United National Fine (J-Thread).

18. IDENTIFICATION OF J-THREADS MIL-S-8879.

a. J-threaded items look just like items threaded with conventional MIL-S-7742 threads.

b. Part numbers are therefore marked on all possible details used in this engine except for threaded item with limited marking area less than 0.200 inch long by 0.500 inch wide.

c. Blue dye is used on J-threaded nuts and bolts at first engine build yet this marking is not permanent. Dye will burn off during operation or will disappear at first cleaning.

d. At disassembly carefully segregate and mark J-threaded hardware to prevent mixing of J-threaded with non J-threaded parts.

19. LUBRICATION OF RUBBER PREFORMED PACKINGS.
(See Table 1.)

CAUTION

Failure to lubricate rubber preformed packings may result in distortion or leakage and possible engine malfunction or failure.

NOTE

PWA 36500 assembly fluid is the preferred packing lubricant for engine oil system packings and should be used for oil system packings only.

a. Apply thin film of lubricant when installing rubber preformed packings. Select lubricant from table 1.

b. Lubricate silicone rubber packings only with VV-P-236 petrolatum. These packings are usually red or cream-colored, and include the following:

AMS 3301	AMS 3334
AMS 3302	AMS 3335
AMS 3303	AMS 3336
AMS 3304	AMS 3338
AMS 3305	AMS 3345
AMS 3315	AMS 3346
AMS 3320	AMS 3356
AMS 3332	AMS 3357

Table 1. Rubber Preformed Packings - Lubrication

Engine System	Packing Material	Lubricant
Fuel	Fluorosilicone rubber (AMS 7273)	VV-P-236 petrolatum
Oil	Fluorocarbon rubber (AMS 7276) or MIL-R-83248 Type I (AMS 7280)	MIL-L-7808 oil PWA 36500 assembly fluid VV-P-236 petrolatum
Air, Water, or Alcohol	Silicone rubber (AMS 7267)	VV-P-236 petrolatum

20. REMOVAL, INSPECTION REPAIR AND INSTALLATION OF BUSHINGS AND BEARING LINERS.

a. Screw bushings:

(1) Remove only if worn or damaged, or if leaking seal needs replacement.

(2) Drill out lockpins if bushing will be replaced.

(3) Remove bushing with appropriate driver.

(4) Refer to specific repair work package for installation of seal-contained, pinned-threaded bushings.

(5) Install new bushing with driver. Drill new lockpin holes and install new lockpins as required.

b. Nonthreaded bushings: removal not required.

(1) Unless scratched or scored, do not disturb glazed surface of bushing.

(2) Polish with P-C-458 crocus cloth and MIL-L-6081 Grade 1010 oil, if bushing is only slightly scratched or scored.

c. Nonthreaded bushings: removal required.

WARNING

Nitric acid is flammable/ explosive and produces toxic gasses when burned. Contaminating combustible materials and metallic powders can result in auto-ignition or explosion. Inhalation of nitric acid can cause death. Skin and eye contact with liquid or concentrated vapors can result in severe burns. Keep ignition sources away. Provide adequate ventilation. Wear protective clothing. Follow special handling precautions.

(1) Etch bushing by swabbing with 10% nitric acid to locate pins, if not easily visible.

(2) Remove lockpins if present.

(3) Drive out pins with a small punch, drift, or drill.

(a) Use drill jig as guide.

(b) Drill only deep enough to free bushing.

(c) For specific drill jig, refer to pertinent engine repair work package.

(d) Use bushing or lever as guide if jig is not available.

(4) Pull or drift out bushing, or use the following method:

NOTE

Grinding may be made easier if bushing is carburized, by locally heating bushing to approximately 400°F (204°C) for 15 to 20 minutes, taking care not overheat.

(a) Grind two grooves on bushing ID, approximately 180 degrees apart, being extremely careful not to grind into housing.

(b) Using a punch, or a drift and hammer, collapse bushing inward and remove.

(5) Install new bushing, aligning oil holes or grooves with those of corresponding boss.

NOTE

Use an oversize bushing or liner as required to obtain proper fit.

(6) Check flange, if present, with a 0.001 inch feeler gage to ensure proper seating.

CAUTION

Do not allow drill to break into any oil passages.

(7) Drill new pin holes, if required, using same drill jig used in drilling out lockpins. New hole shall be at least 30 degrees from existing pin holes.

(8) Transfer-drill new pin hole, using existing pin hole in boss as guide, in case old lockpin was driven out with punch.

(9) Install new lockpins with suitable punch, and peen hole in boss if new bushing was transfer-drilled.

(10) Ream new bushing to size, and polish with P-C-458 crocus cloth and MIL-L-6081 Grade 1010 oil.

(11) Check bushing for ID dimension using appropriate gages.

(12) Clean bushings and oil passages thoroughly after reaming.

(13) Plug unused pin holes, if numerous enough that strength of housing might be affected, using either of the following methods.

(a) Weld holes using filler metal corresponding to housing material. Machine surface of weld area flush with surface of housing.

(b) (Alternate) Fill holes with Devcon F (aluminum putty) sealing compound, using needle-nosed applicator or hypodermic syringe. Pack tightly without trapping air in holes. Cure at room temperature at least 4 hours. Machine excess compound flush with surface of housing.

21. REPLACEMENT, LUBRICATION, AND TORQUING OF STUDS.
(See Figures 8 and 9 and Tables 2, 3 and 4.)

a. Studs - replacement.

(1) Replace with oversize studs, any studs which are loose, stretched or have damaged threads.

(2) Replace any oversize studs as necessary, with the next oversize.

(3) Drill and tap hole for a stepped stud in event stud hole threads are damaged, as long as hole wall is of adequate thickness. (See figure 8.)

(4) Ensure that anchor end of oversize stud does not project beyond end of hole so as to cause interference. File end if necessary to prevent such interference.

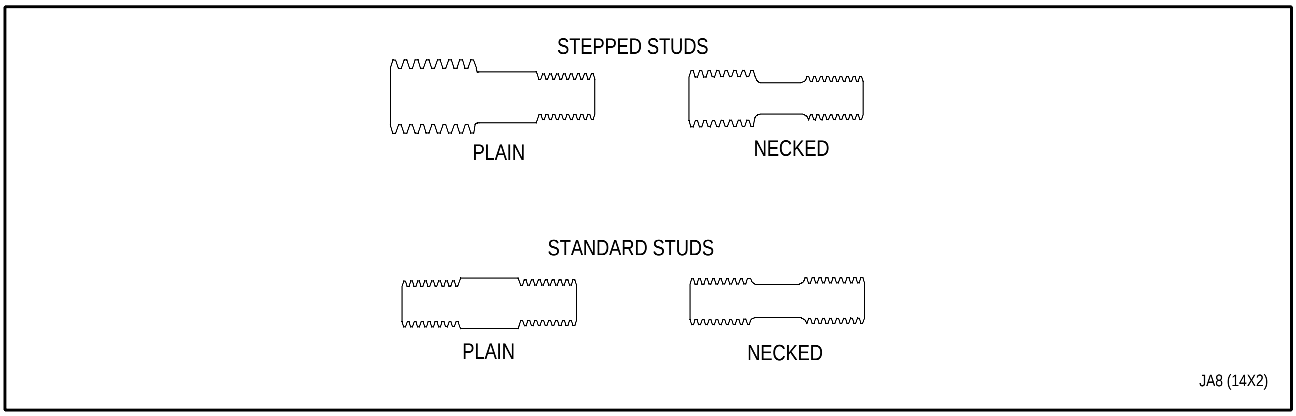


Figure 8. Replacement Stud Types

(5) Reidentify stud with appropriate oversize mark.

(6) Measure projection length from lower edge of any hole in stud intended for lockwire or a cotter pin, instead of end of stud. Refer to applicable repair work package. (See figure 9.)

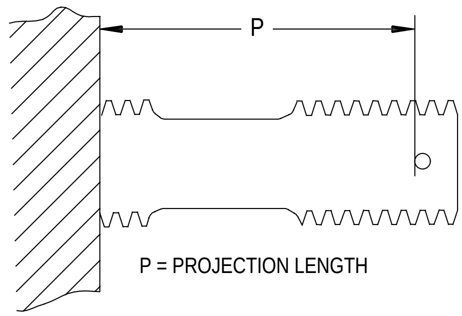


Figure 9. Stud Projection Length

b. Studs - lubrication.

(1) Titanium studs or any stud driven directly into a titanium part to torque value shown in tables 2 and 3. Lubricate drive threads with wet PWA 36035, Fel-Pro C-300 lubricant. Oil is not permitted.

(2) Studs other than titanium. Lubricate drive threads with engine oil, Kendall All-Oil Gear Lube SAE 250, or equivalent.

(3) Studs in self-locking helical coil inserts. Observe torque values of table 4, but studs may be installed either without lubrication or lubricated with one of the following, whichever is preferable for assembly convenience.

(a) Wet PWA 36545, Everlube 382.

(b) Wet PWA 36035, Fel-Pro C-300.

(c) Engine oil.

(d) Baked PWA 36545, Everlube 382. Refer to T.O. 2J-F100-53-1, SWP 098 07.

(e) PWA 550 antigalling compound. Refer to T.O. 2J-F100-53-1, SWP 098 03.

(f) PWA 474, LS 2065 antigalling compound. Refer to T.O. 2J-F100-53-1, SWP 098 04.

(g) PWA 559 antigalling and corrosion preventive compound. Refer to T.O. 2J-F100-53-1, SWP 098 05.

Table 2. Standard Interference Fit Stud Torque Limits

Thread Size (Drive End)	Torque Limits (lb-in.)		
		Maximum	
	Minimum	Necked-down*	Plain**
.164 -32	10	30	30
.190 -24	15	40	45
.216 -24	20	65	70
.250 -20	40	95	105
.3125 -18	85		230
.375 -16	160	210	425
		375	
.4375 -14	200	600	675
.500 -13	250	950	1050
.5625 -12	425	1400	1500
.625 -11	625	1900	2100
.750 -10	1100	3500	3800

*These limits apply where the unthreaded diameter ofthe stud is less than the minimum minor diameter ofthe coarse pitch thread (drive end).

**These limits apply where the unthreaded diameer ofthe stud is equal to or greater than the minimumminor diameter of the coarse pitch thread.

Table 3. Stepped Interference Fit Stud Torque Limits

Thread Size (Drive End)	Torque Limits (lb-in.)		
	Minimum	Maximum	
		Necked-down*	Plain**
.164 -36	10	30	30
.190 -32	15	45	50
.216 -28	20	65	75
.250 -28	40	115	125
.3125 -24	85	240	260
.375 -24	160	450	500
.4375 -20	200	700	800
.500 -20	250	1150	1300
.5325 -18	425	1600	1800
.625 -18	625	2400	2600
.750 -20	1100	4200	4600

*These limits apply where the unthreaded diameter of the stud is less than the minimum minor diameter of the coarse pitch thread (drive end).

**These limits apply where the unthreaded diameter of the stud is equal to or greater than the minimum minor diameter of the coarse pitch thread.

Table 4. Standard and Stepped Studs Installed in Self-Locking Helical Coil Inserts

Thread Size (Drive End)	Torque, (lb-in.)**	
	Minimum	Maximum
.190 -32*	23	45*
.250 -28	52	90
.3125 -24	105	180
.375 -24	140	240
.4375 -20	175	300
.500 -20	260	450
.5625 -18	350	640
.625 -18	525	900

*When drive end is 0.190-24 reduce this value to 40.
**See paragraph 21.b.(3).

c. Studs - torquing.

(1) Burnishing studs may be used, if required, to size the internal thread. These studs may be plain or may be made with two opposed flat surfaces at or below the minor diameter of the thread.

(2) Studs designed to be driven from an extended coarse pitch thread or from wrenching flats adjacent to the coarse pitch thread. Use the plain studs torque values as applicable in tables 2 and 4.

(3) Interference fit studs being driven into nonlocking helical coil inserts. Use torque values shown in table 2.

NOTE

Torques given in tables 2, 3 and 4 are based on stud materials having a minimum ultimate tensile strength of 125,000 psi, corresponding to a maximum hardness of Rockwell C26.

(4) Studs having a hardness of Rockwell C34 or greater. Maximum torque values may be increased by 25%.

(5) Standard interference fit studs (where nominal thread sizes on both ends are the same). Use torque values shown in table 2.

(6) Stepped interference fit studs (where nominal thread size of nut end is smaller than nominal thread size of driven end). Use torque values shown in table 3.

(7) Studs being driven into self-locking helical coil inserts. Use torque values shown in table 4. These values apply both to standard and stepped studs.

(8) Select another stud, in event that torque required to drive a stud directly into a boss to a specified projection distance is less than minimum or greater than maximum values given in tables 2 and 3.

22. INSPECTION OF UNIVERSAL FITTINGS.

a. Clean threads of universal fittings (locknut-type or elbow-type) with stiff bristle nonmetallic brush and P-D-680 solvent.

b. Visually inspect fitting for thread damage, using 3X magnification. Thread surface shall be smooth and free from nicks, dents and burrs. Reject any fittings having broken threads or indication of extreme roughness.

c. Thoroughly clean acceptable fittings prior to installation.

23. TORQUE CHECK FOR REUSE OF SELF-LOCKING FASTENERS.
(See Figure 10 and Table 5.)

a. Check self-locking nuts, bolts and helical coil inserts before reuse per table 5; and when checking nuts, observing the following test conditions as applicable:

(1) Condition A.

NOTE

Nut may be permanently attached to a bracket or similar part.

(a) Nut being tested: Unplated nickel alloy, AMS 6304 steel, or corrosion and heat resistant steel (stainless steel).

(b) Bolt used to test nut: If test bolt is nominally 0.190-32 UNF-3A, 0.190-24 UNC-3A, or larger, its diameter shall be reduced (major, minor and pitch) by 0.003 inch from standard dimensions. Refer to figure 9 for explanation of terms. Bolt is then silver plated 0.0003 to 0.0006 inch thick for test purposes. Refer to T.O. 2J-F100-53-1, SWP 092 07 or SWP 092 08.

(2) Condition B.

(a) Nut being tested: Unplated nickel alloy, AMS 6304 steel, or corrosion and heat resistant steel (stainless steel) which have threads overcut to allow for plating, shall be silver plated 0.0003 to 0.0006 inch thick for test purposes. Refer to T.O. 2J-F100-53-1, SWP 092 07 or SWP 092 08.

(b) Bolt used to test nut: Unbolted with thread size per table 5.

(3) Condition C.

(a) Nut being tested: Unplated low alloy steel (other than AMS 6304) nut shall be cadmium plated 0.0002 to 0.0005 inch thick. Refer to T.O. 2J-F100-53-1, SWP 092 05.

(b) Bolt used to test nut: Cadmium plated bolt with thread size per table 5.

(4) Condition D.

(a) Nut being tested: Unplated aluminum nut.

(b) Bolt used to test nut: Cadmium plated bolt with thread size per table 5.

b. Discard any fastener which does not meet requirements of table 5 for locking capability. Do not attempt repair.

Table 5. Torque Check For Reuse of Self-Locking Nuts, Bolts, and Helical Coil Inserts

Fine Thread Series		
Mating Bolt Thread Size (1)	Max Locking Torque (2) (3)	Min Breakaway Torue (3)
0.112 -48 NF-2A	3	0.5
0.138 -40 NF-2A	6	1.0
0.164 -36 NF-2A	9	1.5
0.190 -32 UNF-3A	13	2.0
0.250 -28 UNF-3A	30	3.5
0.3125 -24 UNF-3A	60	6.5
0.375 -24 UNF-3A	80	9.5
0.4375 -20 UNF-3A	100	14.0
0.500 -20 UNF-3A	150	18.0
0.5625 -18 UNF-3A	200	24.0
0.625 -18 UNF-3A	300	32.0
0.750 -16 UNF-3A	400	50.0
0.875 -14 UNF-3A	600	70.0
1.000 -14 NF-3A	800	92.0
1.125 -12 UNF-3A	900	117.0
1.250 -12 UNF-3A	1000	143.0

NOTES
(1) Observe test conditions of paragraph 23.a.
(2) Installation or removal.
(3) Torques measured in pound-inches at room temperature and lubricated with engine oil.

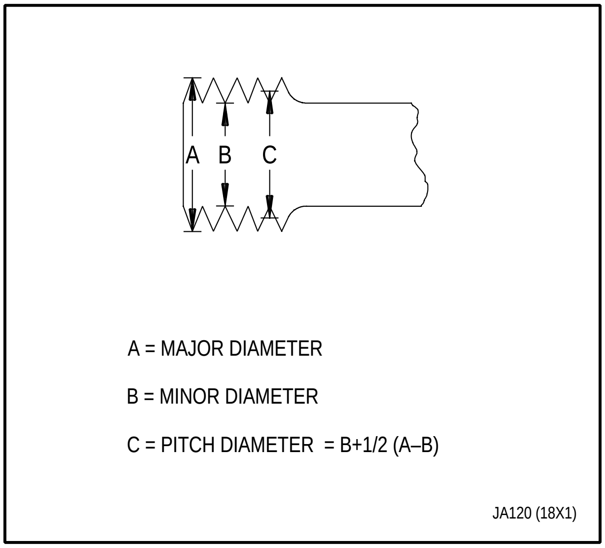


Figure 10. Thread Diameters

24. SHEAR-FITTING OF SILVER PLATED SPLINES.

a. Silver shear-fitting of mated parts is required when the following conditions exist:

(1) Splines are highly stressed, or are subjected to reversed cyclic loading.

(2) Heavy pressure for assembly cannot be used.

(3) Even slight spline looseness is undesirable.

b. Fit shall not be attainable with hand push. If fit between splines having silver plate can be attained with hand push, refit as follows:

(1) Strip external splines, and silver plate to a thickness of 0.0008 to 0.0012 inch. Refer to T.O. 2J-F100-53-1, SWP 092 07 or SWP 092 08.

(2) Assemble under pressure using appropriate base, plate and drift on arbor press. Mark mating parts to identify corresponding splines.

(3) Disassemble and remove silver chips.

c. Ensure that after shearing, the following requirements are met:

(1) Shear surface shall be shown on at 75% of both sides of each spline.

(2) Shear surface contact shall be full spline length unless otherwise specified.

(3) Width of contact pattern may vary, but shall average at least 30% of spline height.

(4) There shall be no evidence of cocking.

(5) Strip silver and repeat entire procedure, if foregoing requirements are not fully satisfied.

d. Assemble in same position as when sheared.

25. FEATURE CONTROL SYMBOLS. (See Figure 11.)

a. Feature control symbols are applied on repair illustrations in this manual to designate form, position and size tolerance controls of both single features or the relationship between two or more features to specified characteristics (e.g., flatness, parallelism, etc.). A typical feature control symbol is shown in figure 11. These symbols are interpretated within the key to the applicable illustration. If a more comprehensive interpretation is required, refer to T.O. 2J-F100-53-1, SWP 091 09.

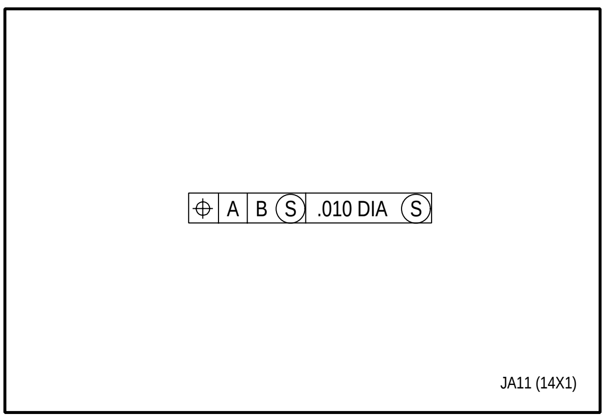


Figure 11. Feature Control Symbol

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES - ANTIFRICTION BEARINGS, GENERAL HANDLING, REMOVAL AND INSTALLATION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0	10 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Bearings, Antifriction, Preparation for Delivery	MIL-B-197
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Marking, General	WP 023 00
Jet Engine Antifriction Bearing Handling, Removal, Cleaning, Inspection and Installation	T.O. 44B-1-15
Maintenance Instructions, Antifriction Bearings	T.O. 44B-1-102

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Bags, interior packaging	MIL-B-117
Barrier material	MIL-B-121, L-P-377, or L-P-378
Oil, corrosion preventative	MIL-C-8188
Oil, lubricating	MIL-L-7808
Oil, mineral seal	Exxon Mentor No. 28 or Texaco 300 oil or Shell Pella 911
Petrolatum, white	VV-P-236
Solvent, petroleum	P-D-680, Type II Grade A, Class I

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for depot maintenance handling, removal and installation of antifriction bearings.

2. NOMENCLATURE OF BEARING COMPONENTS.
(See Figure 1.)

a. Bearing component nomenclature is illustrated in figure 1, and is in accord with that used for the Antifriction Bearing Manufacturers Association (AFBMA). Use this nomenclature in all inspection reports.

3. INSPECTION REPORTS.

a. Prepare an inspection report, beginning at disassembly. Note obvious failures such as seizing, fracturing or cracking. Include only abnormal conditions, such as insufficient lubrication, overheating, foreign material, evidence of misalignment, etc. Report total operating time.

4. GENERAL PRECAUTIONS.

a. Place each bearing, or both units of each duplex pair, in an individual container, upon removal from the engine.

b. Do not scramble components from one bearing to another at this or any subsequent handling.

c. Handle bearings as little as possible, wearing synthetic rubber gloves, nylon mesh gloves with polyethylene palms and fingers or clean cotton gloves. If cotton gloves are used, change them before there is any possibility of contaminating bearings by perspiration.

d. Handle bearings and their components with care. No metallic clicking sound shall be made during handling, since this is an indication of possible damage.

e. If one unit of a duplex bearing is rejected, the other unit shall be retained for possible rematching.

f. No work is permitted on internal load carrying surfaces.

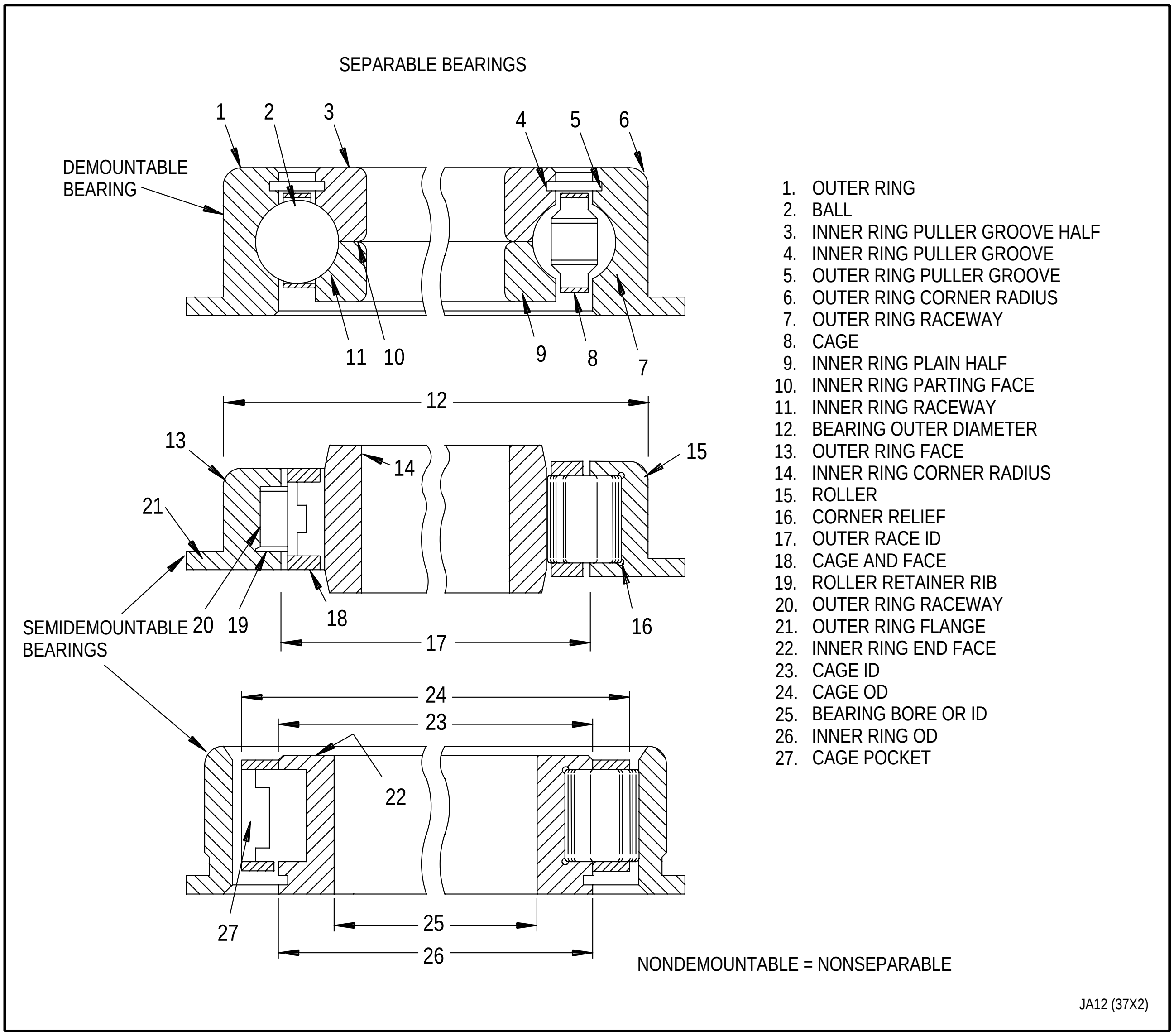


Figure 1. Bearing Nomenclature

g. Do not transport bearings in an electrically propelled truck, due to possible magnetization.

h. Keep to a minimum any rework polishing of mounting surfaces, and observe all dimensional limits.

i. Remove excess oil, if necessary, by wiping only with a clean, dry, lint-free cloth or paper wipe. Do not vapor degrease.

5. UNPACKING NEW BEARINGS.

CAUTION

Marking not allowed on functional or nonfunctional surfaces of bearings. Bearing damage and stack up deviations are induced by marking on bearings.

a. Handle bearings only with clean gloves per paragraph 4.c.

b. Do not remove bands which hold bearings together, and do not disassemble ball bearings.

c. Disassemble carefully the removable ring from roller bearings, which are received assembled.

NOTE

- An alternate method of spray cleaning new bearings as given in T.O. 44B-1-15 may be used, provided desired cleanness can be obtained.
- New bearings need not be completely depreserved for preliminary inspection of ID and OD fits only. The preservative may be wiped from ID and OD; then replaced after completion of inspection.

d. Pressure flush bearings using mineral seal oil at 150° to 170°F (66° to 77°C) and at a pressure of 15 to 25 psig. Flush until all preservative grease is removed. Replace mineral oil when contaminated by preservative compound to the extent that specific gravity exceeds 0.840. (Normal specific gravity is 0.820 to 0.835.)

CAUTION

To prevent sludging and contamination of engine oil, never use a petroleum base oil on a bearing which will be installed in an engine using synthetic lubricating oil such as MIL-L-7808.

e. Remove mineral seal oil by cleaning with P-D-680, Type II petroleum solvent. If pressure flush is available, use 25 to 35 psig for one minute minimum. Immediately after this cleaning, dip bearing in MIL-L-7808 lubricating oil, then wrap in MIL-B-121 grease-proof paper, with glossy side toward bearing.

6. INSPECTING BEARINGS.

a. Refer to T.O. 2-1-111.

7. INSTALLATION OF BALL AND ROLLER BEARINGS.

a. Protect antifriction bearings against contamination. Provide protective covering during storage or when bearings are exposed during engine assembly.

b. Handle ball or roller bearings wearing only clean, lint-free gloves. Refer to T.O. 44B-1-15 for general instructions for handling and installation of antifriction bearings.

CAUTION

Avoid excessive heat, which can cause detrimental hardness changes. Observe temperature limits in pertinent work packages/subordinate work packages.

c. Check size and trueness of shafts and bearing races before heating, in order to avoid an abnormal fit.

NOTE

- If thermostatically controlled hot oil bath equipment is not available, thermostatically controlled ovens may be used.
- Keep hot oil tanks closed when not in use, to keep out airborne dirt and abrasive particles. Change oil and clean tanks periodically as required.

d. Wrap each bearing separately in aluminum foil and place for 12 minutes in an oven preheated to 225° to 275°F (107° to 134°C).

e. When assembling inner race of bearing on a mating shaft, expand inner race of demountable or entire nondemountable bearing, by immersion in a MIL-L-7808 oil bath for 15 to 30 minutes, thermostatically controlled at 225° to 275°F (107° to 134°C).

f. Place bearings on heavy screen or a grid of rods extending three or more inches above tank bottom. This is necessary in order to surround bearings with oil at a constant temperature, to allow dirt to settle to bottom of tank, and to protect bearings from contamination by settlings.

g. Remove bearings from heated oil bath, drain and wipe excess oil from journals using a clean, dry, lint-free cloth or paper wipe.

h. Force shall not be used in assembly of parts. Shock loading of bearings may cause rollers to fall out. Use an arbor press wherever possible. If difficulty is encountered, disassemble parts and inspect for burrs or other interference.

i. Unless otherwise specified, manufacturer’s number on bearing races will face mechanic as bearing is being installed.

j. During installation of roller bearing, rollers shall be rotated with respect to outer race. This will reduce possibility of hang-up of rollers, and help detect hang-up, if it occurs.

k. When necessary to hold roller bearing in place, apply VV-P-236 petrolatum, or equivalent, to rollers immediately before assembly. Position rollers radially inward against inner race, where they will be held by the petrolatum during assembly.

l. Large spannernuts used to secure main bearings or seals to shafts and housings frequently have small burrs at the spanner slots. Burrs will scar faces of bearings or seals if spannernuts are installed in reversed position. Ensure that any such burrs are removed before installation.

m. Remove or protect prepacked bearings when washing assembly where these bearings are used.

n. Main shaft bearings which meet all inspection requirements except ID or OD dimensions may be used by selective fittings of mating parts within engine to achieve clearance index limits.

8. PRESERVATION OF BEARINGS.

a. Extended preservation of F229 bearings shall be accomplished per these guidelines or MIL-B-197. Extended preservation per T.O. 2-1-111 is acceptable, however, drying of bearings with compressed air is not recommended. Use an oven or infrared lamp for drying bearings prior to preservation.

b. Keep handling of bearings to a minimum. Do not handle bearings with bare hands. Wear clean gloves of synthetic rubber, or lint-free nylon mesh. If neither one is available, wear clean lint-free cotton gloves. Refer to T.O. 2-1-111.

c. Use nylon or synthetic rubber gloves while handling bearings. Do not handle bearings with bare hands.

d. Care in dust control shall be maintained. Presence of dust and dirt producing sources, such as cartons, trash barrels, etc, shall be kept to a minimum. Smoking, eating, and drinking shall not be permitted in the bearing handling areas.

e. Perform bearing cleaning, drying, preserving, and packaging in an environment controlled to 75°F (24°C) MAX with relative humidity not to exceed 50%. Refer to MIL-B-197.

f. No mechanical cleaning allowed. This includes tumbling, grinding, wire-brushing, sanding, polishing or any other processes which will alter the original surface.

g. Waive NDI magnetic particle inspection for all mainshaft bearings.

h. Final cleaning, drying, preservation, and packaging operations shall progress in an uninterrupted series of operations.

i. During the cleaning process, the mainshaft bearings should remain assembled. Bearings that may disassemble and those which have mated parts shall be handled with care to prevent mismatching.

j. Cover all solvent and preservative tanks when not in use.

k. Clean bearings per SPOP 14 or SPOP 214. Refer to T.O. 2-1-111.

CAUTION

Do not dry bearings with compressed air. Compressed air may damage bearings.

l. Dry bearings in oven or infrared dryer at 225° to 275°F (107° to 135°C) immediately after cleaning.

m. Dip bearings in MIL-C-8188 corrosion preventative oil.

n. Apply final preservation and demagnetize bearings.

o. Intimate wrap bearing per MIL-B-197 immediately upon removal from MIL-C-8188 oil. Wrap shall be nylon or polyester film (1 mil thick) per L-P-377 Type 1, polyethylene film (2 mil thick) per L-P-378, and polyethylene kraft per MIL-B-121.

p. Immediately upon completion of intimate wrap, bag the bearing and evacuate air from the bag. Bag per MIL-B-117 Type 1, Class E. Vacuum packaging machine such as the Supervac Model GK 165 (with nitrogen purge) or equivalent shall be used for evacuation of air. Air evacuation to be accomplished as per MIL-B-197. In addition, nitrogen purge is recommended.

q. Package and identify mainshaft bearings per T.O. 44B-1-102.

r. Immediately after vacuum packaging, wrap bearings in plain paper wrap to protect vacuum bag during handling.

s. Attach marking to outer wrap so it is accessible without damaging the protective wrap. Marking shall include but not be limited to:

- title of packaging specification
- preservative used
- date of preservation
- part number
- part serial number

t. Clean and represerve bearings if damage to protective wrap is noticed.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES - MARKING, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0	8 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Resin Coating, Permanent, Application of - - - - - - - - - -	MIL-R-6800
Introduction and General Information - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Marking, Temporary -	SWP 023 01
Marking, Electrochemical (SPOP 401) - - - - - - - - - - - - -	SWP 023 02

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Coating, clear spray	Krylon
Coating, resin	MIL-R-3043
Varnish, phenolic resin	AMS 3132

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance marking of parts.

2. GENERAL.

a. Marking of engine parts, assemblies, or weldments shall be applied in a manner not detrimental to the part, and ensuring maximum legibility and durability.

b. Reidentification marking shall be adjacent to, or in a location similar to that of original marking, except as otherwise specified in work packages/ subordinate work packages.

c. Where reidentification or corrective marking is required, deletion of existing mark or portion of mark may be necessary. Using an allowable marking method, draw a wavy line, loop, flat oval, or X’s through the character(s) or symbols(s) to be deleted.

d. Unless specified in work packages/subordinate work packages, all marking characters shall be 0.060 to 0.160 inch in height. In case of unusual part size or configuration, limits of 0.016 to 0.500 inch are permitted.

e. Unless specified in work packages/subordinate work packages, offset holes in mating parts may be identified by vibration peening an X adjacent to offset hole.

f. Part that is to be plated, anodized, hard coated, painted, or otherwise coated shall normally be marked prior to plating or coating by an approved permanent marking method which will be legible after final surface treatment.

g. Mark only on a surface which, after assembly, does not move relative to any contacting surface. To mark a part following plating or coating, perform the following:

(1) External surfaces. A temporary mark may be applied using ink stamping with an overcoating of Krylon Crystal Clear, or equivalent.

(2) Internal surfaces. Where specifically allowed in work packages/subordinate work packages, a permanent mark may be applied using vibration peening. A temporary mark may be applied using ink stamping with an overcoating of AMS 3132 phenolic resin varnish or MIL-R-3043 resin coating applied per MIL-R-6800 coating process for transparent resin varnish.

3. TEMPORARY MARKING.

a. Temporary methods of marking are those by which marking will ensure identification during ordinary handling, storage, and final assembly. Approved marking methods are listed in SWP 023 01.

4. PERMANENT MARKING.

(See Figure 1.)

a. Permanent methods of marking are those by which marking shall remain legible throughout entire service life of part.

b. Permanent markings shall not extend onto any radius, chamfer, sharp edge, or fillet adjoining surface marked.

c. When required, bearings shall be marked in an approved area, using vibration peening, electrolytic etch, or drag impression. Vibration peening is permitted on bearing rings even though usually limited to metals having less than a hardness of Rockwell C45, or equivalent. All raised metal surrounding characters on contact surfaces of ball and roller bearings shall be removed.

CAUTION

Electric arc scribing, acid etching, and soapstone are possibly detrimental and shall not be used for marking engine parts.

Do not electrolytic etch anodized surfaces.

d. The following marking methods are not permitted if part has greater than a hardness of Rockwell C45 or equivalent, at time of marking:

(1) Metal stamping. Characters are produced by forcible displacement of metal. Metal raised by this method more than 0.001 inch shall be carefully removed. Parts shall have marking area properly back-supported to avoid detrimental stresses. Stamps shall produce fillets and radii at all intersecting surfaces of characters. Use one of following:

Hammer - characters are produced individually or in groups by force applied mechanically or by hand.

Press - characters are produced individually or in groups by force applied with steadily increasing controlled pressure.

Roll - characters are produced by rotating action of either part or tool, or both, when in contact with each other under controlled force.

(2) Vibration peening. Characters are produced by a vibrating, radius-tipped, conical tool. This method may be used on parts for which diamond drag or roll marking was formerly specified. Unless otherwise specified by work packages/ subordinate work packages, this method shall not be permitted for parts having a hardness of Rockwell C-45 or equivalent, at time of marking. Vibration peening may be done by either of following:

Manual method - tool is hand guided and has single tip.

Mechanical method - tool is mechanically guided and has either a single tip, or multiple tips producing one or more complete characters simultaneously.

(3) Engraving. Characters are produced by rotating cutter or grinder, using either of the following:

Manual method - cutter or grinder is hand guided.

Mechanical method - cutter or grinder is mechanically guided.

(4) Branding. Characters are produced by burning or displacing nonmetallic material with heated tool.

(5) Drag impression. Characters are produced by mechanically guided, freely rotating, radius-tipped, conical tool.

(6) Blasting. Characters are produced by impingement of abrasive substance confined to area of characters by stencil.

(7) Electrolytic etching (electrochemical marking). Characters are produced by electrolysis confined to area of characters by a stencil. Procedure is outlined in SWP 023 02. Depth of mark may be deep or shallow, according to type of equipment and electrical current used. Deep etch is considered a permanent marking method, whereas shallow etch may be classified either permanent or temporary. Do not confuse this method with electric arc scribing, which is not an approved marking method.

e. Marking depth. Unless otherwise specified in work packages/ subordinate work packages, maximum depth of marking shall be as follows:

Marking Method	Depth, Inches
Metal stamping, hammer	0.010
Metal stamping, press or roll	0.006
Vibration peening, manual or mechanical	0.006
Engraving, manual or mechanical	0.003
Branding	0.010
Drag impression	0.003
Blasting	0.0005
Electrolytic etching, deep	0.002
Electrolytic etching, shallow	0.0003

f. Marking symbols.

(1) Arrow and dimension. Some disks and spacers may be marked with an arrow and a dimension. This indicates that the mating diameter was plated at manufacture. The arrow points in the direction of the diameter plated, either front or rear. The adjacent dimension gives the actual measurement before plating.

(2) Beehive symbols. A beehive symbol marked on a part indicates that the part has been repaired by plating, plasma spraying, flame spraying, or epoxy at manufacture as a deviation from blueprint. Each beehive symbol and its significance is shown in figure 1. When practicable, symbol is located both near part number and repaired area.

(3) When a -1 or -2 follows a beehive symbol it indicates the following:

-1 PWA 53-5 coating only

-2 PWA 53-5 and PWA 53-47 used

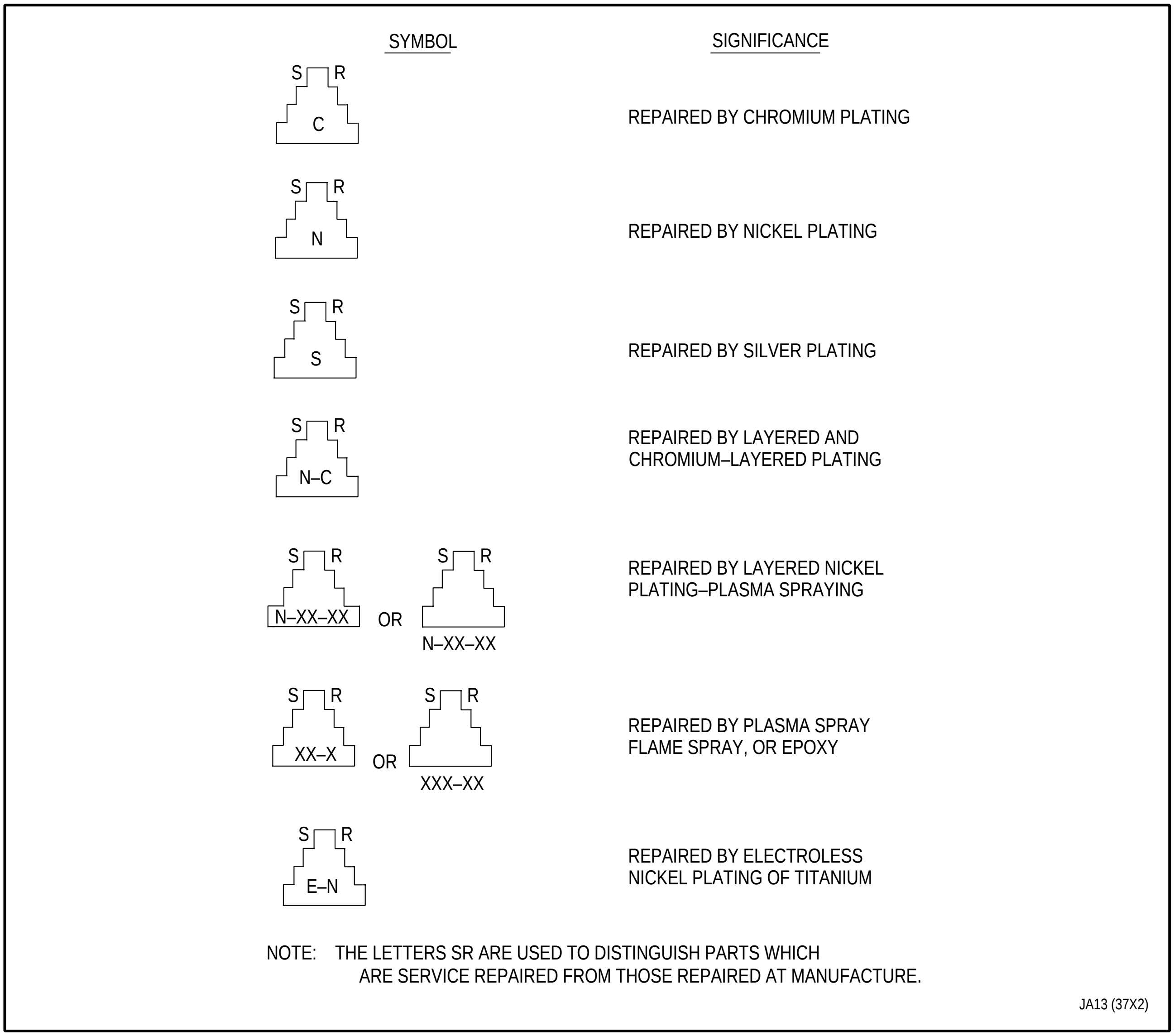


Figure 1. Beehive Symbols

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES - MARKING, TEMPORARY

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0	6 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Marking, Electrochemical (401)	SWP 023 02

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Crayon, Red	Phano No. 71
Crayon, Silver, Metal Marking	Anadel No. 1936 or Colorbrite Color-Tex No. 1843 Silver No. 2101 Dye, Layout (purple) Micro-Supreme No. 451
Ink, Marking	Carter’s XX 425 (black)
Ink, Dykem	XXX 122 (white)
Ink, Fast Drying (for use with Brushpen No. 57)	TEX-Rite 400-1 (black), 400-2 (red) 400-7 (purple)
Ink, Fast Drying (for use with Felt Wick Pen)	Speedry Instant Dry Ink
Ink, Metal Marking, black or white	No. 977-9
Ink, Volger’s Opaque Black	-
Marker, Brushpen No. 57	-
Marker, Cado	-
Marker, Felt Wick Pen	-
Marker, Marks-A-Lot	-
Marker, Skilcraft - Broad, Fine, or Audio-visual-type Tip	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance temporary marking.

2. GENERAL.

a. Temporary methods of marking are those by which marking will ensure identification during ordinary handling, storage, and final assembly.

b. Marking pencils shall not leave residues of carbon, zinc, copper, lead, or similar contaminant which could be detrimental to parts when subjected to high temperature. If unauthorized marking material has been applied, marks shall be thoroughly removed by method appropriate for marking material and part composition.

c. When using a marking pencil, marks shall not be applied to the surfaces of carbon seal plates or to the mating surfaces of carbon seal plates or to the mating surfaces of finished machined parts. Heavy deposits of marking material could adversely affect clearances and runout.

d. Inks used in marking are permitted to have a slight etching action, provided etching does not injure surface.

e. Electrolytic etching (electrochemical marking). Do not electrolytic etch anodized surfaces. Characters are produced by electrolysis confined by stencil. Procedure is outlined in T.O. 2J-F100-53-1, SWP 023 02. Shallow electrolytic etch may be used as a temporary marking method when specified in work packages/subordinate work packages.

3. MARKING MATERIALS, COLD SECTION ENGINE PARTS ONLY.

a. Volger’s Opaque Ink (Black).

b. Dykem Ink KX425 (Black).

c. Dykem Ink KXX122 (White).

d. Carter’s Ink No. 451 (Black).

4. MARKING MATERIALS FOR EITHER COLD SECTION OR HOT SECTION ENGINE PARTS.

a. Felt Wick Pen with Speedry Instant Dry Ink.

b. Brushpen No. 57 with Tex-Rite Instant Dry Ink. Ink Types: 400-1 (black); 400-2 (red); 400-7 (purple).

c. Marks-A-Lot Marker.

d. Cado Marker.

e. Hot Section use of Ink #977-9 is limited to turbine blades.

f. State Stamp Metal Marking Ink #977-9, black or white.

g. When used in Hot Section, apply layout dye to parts very lightly.

h. Micro-Supreme (purple) Layout Dye may be used for marking parts directly exposed to engine gaspath such as combustion chamber liners and turbine blades, vanes, and disks.

i. White chalk.

j. Skilcraft Marker: Broad tip, Fine tip, or Audiovisual (black).

NOTE

Limited usefulness because easily obliterated or smeared.

k. Dixon Phano No. 71 Red Pencil (Crayon).

l. Eberhard Faber Colorbrite Silver No. 2101 Pencil (Crayon).

m. Dixon Anadel Silver No. 1936 Pencil (Crayon).

n. General Pencil Color-Tex Silver No. 1843 (Crayon).

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES - MARKING, ELECTROCHEMICAL (SPOP 401)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, electrolytic marking, immersion-type, concentrate	Lectroetch LIC or Monode #90 Cleaner/Inhibitor
Cleaner/neutralizer, electrolytic marking, for ferrous alloys	Electromark #1 Cleaner of Monode #15-200 Cleaner/Inhibitor or Lectroetch #2 Cleaner
Cleaner/neutralizer, electrolytic marking, for nonferrous alloys	Electromark #2 Cleaner or Monode #15 Cleaner/Inhibitor or Lectroetch #3 Cleaner
Electrolyte, for aluminum and other alloys	Electromark P-16 or Monode C-10 or Lectroetch LNC-2
Electrolyte, for ferrous and other alloys	Electromark P-10 or Monode F-10 or Lectroetch LNC-1
Electrolyte, for copper, nickel, and other alloys	Electromark P-14 or Monode B-10 or Lectroetch #220A
Oil, corrosion preventive	AMS 3065 or MIL-C-15074
Oil, corrosion preventive water-displacing	Reilly-Whitman X59-58 or Quaker Ferrocote 362K-2 or Pakoil No. 4042
Pad, deep etch	Electromark #7265-1-D or Monode 50150FD-SC
Pad, electrolyte	Electromark 4397-1 or Monode 50150SC or Lectroetch electrolyte pad
Solvent, petroleum	P-D-680, Type II
Stencil, electrolytic marking	Electromark 9001 paper or Monode D-I paper or Lectroetch L paper

CONSUMABLE MATERIALS (continued)

Nomenclature	Specification/Vendor Part Number
Tissue, wiping, neutralizer-treated	Electromark #2500 Neutracleaning wiping tissue or Lectroetch neutralizer-treated wiping tissue
Tissue, wiping	Kimberly-Clark Kimwipes #900-S or Scott Micro-wipes

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance electrochemical (electrolytic etch marking.)

2. GENERAL.

a. Electrolytic marking produces sharp impressions without distortion on almost any bare metal or on most plated surfaces, using a small amount of electric current and a salt solution (electrolyte). Etching current is applied through a stencil by a hand-held marking tool, while a grounding clip is attached to the object being marked. This method is not suitable for surfaces coated with a nonconductive film.

b. When alternating current is used, a mark is created by etching out metal and then plating into the impression a stable compound of the basis metal. In most cases this compound is an oxide, usually dark in color.

c. Shallow etch (to a depth of 0.0003 inch) may be done with a standard power unit using alternating current, except in the case of aluminum, for which direct current is used. Shallow etch may also be done with low current DC.

d. Deep etch (0.0005 to 0.002 inch) is done with a heavy duty power unit, applying direct current, and using a highly fibrous deep etch pad saturated with electrolyte.

e. In order to prevent subsequent salt corrosion, the marked area shall be neutralized by wiping or soaking with an appropriate neutralizing solution.

3. EQUIPMENT.

(See Table 1.)

NOTE

The following list of possible sources of marking equipment is intended only for the operator’s convenience. Use of these items or suppliers is optional.

a. Power source.

(1) Electromark X-100 shallow etch power unit (0 to 10 Amp).

(2) Monode M-150 electrolytic etch power unit (1.5 to 15 Amp).

(3) Electromark M-400 electrolytic etch power unit (1.5 to 15 Amp).

(4) Electromark 961-1 deep etch power unit (0 to 25 Amp).

b. Marking tools.

(1) Electromark 4397-2A rectangular hand marker.

(2) Lectroetch LE 28287 rectangular hand marker.

(3) Electromark 14040 hand dip square marker.

(4) Lectroetch LE 25588 hand dip square marker.

(5) Monode Marking Co. Hand dip square marker.

c. Cord Set, Neoprene Rubber Insulated.

(1) Electromark 4309 BA.

(2) Monode Marking Co.

d. Electrolyte pads.

e. Deep etch pads.

f. Stencil sheets (for making 1 to 100 impressions per die or type-cut mark).

g. Photosensitive stencils (for making 100 to 200 impressions; custom-prepared by Electromark, Monode, or Lectroetch).

h. Plastic stencils (for making 2000 to 5000 impressions; custom-prepared by Electromark, Monode, or Lectroetch).

i. Electrolytes. (See table 1.)

j. Cleaners (Neutralizers). (See table 1.)

4. PROCEDURE.

a. Preparation.

(1) Surfaces shall be electrically conductive for electrolytic marking. Painted, lacquered, or enameled surfaces shall be stripped. Aluminum, magnesium, or titanium shall be marked before application of an anodic coating.

(2) Degrease and/or clean using appropriate cleaning work package until reasonably free of scale and oxide.

(3) Grit-blasted, peened, or porous steel surfaces require a thin film of P-D-680, Type II petroleum solvent or MIL-C-15074 corrosion preventive oil before marking, to avoid a blurred mark and/or possible corrosion.

Table 1. Electrochemical Marking Specification Chart

Surface to Be Marked	Electrolyte(1) (See Key.)	Type of Current	Color of Etch	Cleaner (See Key.)	Comments
Aluminum alloys	A A	AC DC	Black White	B B	Allow to set before cleaning. Usually applied to bright-finished or polished surfaces.
Brass, bronze	C, D	AC DC	Black Clear	B B	
Cadmium plate	D	AC	Black	B	
Chromium plate	A	AC DC	Clear Clear	B B	
Cobalt alloys	C, A	AC DC	Black Clear	B B	Oil lightly before marking if surface is roughened.
Columbium - See titanium					
Copper alloys	D	AC DC	Black Clear	B B	
Hastelloys	D, C	AC	Black	B	
Inconels	C	AC	Black	B	
Magnesium alloys	A	DC	Clear	F	Oil lightly before marking.
Nickel alloys	A, D	AC	Black	B	
Nickel-cadium plate	D, A, C	DC	White	B(2)	

Table 1. Electrochemical Marking Specification Chart (continued)

Surface to Be Marked	Electrolyte(1) (See Key.)	Type of Current	Color of Etch	Cleaner (See Key.)	Comments
Nickel electroless	A, D	AC	Black	B	
Nickel plate	A, D	AC	Black	B	
Silver plate	D, C	AC DC	Black Clear	B B	Allow to set before cleaning
Steel, low alloy	C, A	AC	Black	B, E	Oil lightly before marking if surface is roughened.
Steel, corrosion and heat resistant	A, C	AC DC	Black Clear	B, E B, E	
Titanium and columbium alloys	C	AC	Dark	B	

NOTE

(1) Whre more than one electrolyte is listed, order is that of normally preferred choice.

(2) Alternate cleaner: Wiping tissues saturated with AMS 3065 corrosion preventive oil, or corrosion preventive, water displacing oil.

Key to Electrolytes and Cleaners:

A Electrolyte - for aluminum and other alloys.

B Cleaner - Neutralizer-treated wiping tissue.

C Electrolyte - for ferrous and other alloys.

D Electrolyte - for copper, nickel, and other alloys.

E Cleaner - Wiping tissue saturated with cleaner/neutralizer for ferrous alloys.

F Cleaner - Wiping tissue saturated with cleaner/neutralizer for nonferrous alloys.

b. Marking.

(1) Mark part, using only enough pressure to assure adequate, full contact of part with electrolyte.

CAUTION

- Electrolytic marking shall be shallow etch unless otherwise specified in work packages/ subordinate work packages.
- Hand marker shall be completely insulated to prevent burning workpiece.
- Do not use a damaged marking tool.

(2) Use electrolyte and current (AC or DC) according to table 1.

CAUTION

Marking tool and workpiece shall not move during timed cycle.

(3) Determine time of contact by usage. In most instances a 2 or 3 second dwell is sufficient. Continued application for more than 4 or 5 seconds will usually cause premature deterioration of the stencil with no appreciable increase in density of the mark.

(4) Allow soft metals such as silver, zinc, copper, and cadmium to stand a few seconds after marking before applying cleaner neutralizer. This allows dark residue to set and form a permanent coloring.

c. Preservation.

(1) Wipe off any liquid electrolyte.

(2) Within 3 minutes after marking, immerse part in a solution of one part electrolytic marking cleaner/neutralizer concentrate to 19 parts water for a minimum of 2 minutes; or wipe with a wiping tissue saturated with appropriate cleaner selected from table 1. Cleaner-treated tissues are also available.

(3) If a water-base cleaner is used, dry part thoroughly before oiling, to prevent entrapment of corrosive deposits.

(4) Preserve part by wiping or dipping in MIL-C-15074 corrosion preventive oil.

WORK PACKAGE

TECHNICAL PROCEDURES

VACUUM LEAK CHECK
USING PWA 50003 CARBON SEAL TESTER

GENERAL PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	17	7	0	9	0
4 - 5	0	8	17	10 Blank	0
6	17				

REFERENCE MATERIAL REQUIRED

Title	Number
Operation And Maintenance Instructions with Illustrated Parts Breakdown - PWA 50003 Carbon Seal Tester - - - - -	T.O. 33D4-6-498-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

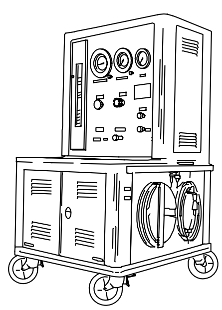
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Tool Nomenclature	Tool Number
2	VACUUM LEAK CHECK - USING PWA 50003 CARBON SEAL TESTER	
	CARBON SEAL TESTER -	PWA 50003

ILLUSTRATED SUPPORT EQUIPMENT



PWA 50003 –C

Figure T1. PWA 50003 Tester

1. INTRODUCTION.

a. This work package contains instructions for performing bearing compartment leak check, as referenced per applicable manual work package.

2. VACUUM LEAK CHECK - USING PWA 50003 CARBON SEAL TESTER.

(See Figures 1 and 2.)

NOTE

- To ensure proper operation, self-test shall be performed each time PWA 50003 carbon seal tester is used.
- Limits apply from sea level to 5,000 foot altitude.

a. Perform self-test on PWA 50003 carbon seal tester as follows. For further PWA 50003 tester operating and service instructions, see T.O. 33D4-6-498-1.

(1) Attach hoses per figure 1.

(2) Perform PWA 50003 tester operating procedures per figure 2.

(3) Airflow leakage shall be 10.0 ±0.1 phr. If leakage is not within limits refer to T.O. 33D4-6-498-1 for specific PWA 50003 tester operating and service procedures.

b. Vacuum leak check bearing compartment as follows:

(1) Install tooling per applicable work package.

(2) Perform PWA 50003 tester operating procedures per figure 2.

(3) Airflow leakage shall not exceed limits specified in applicable work package.

c. Following successful vacuum leak check, remove tooling.

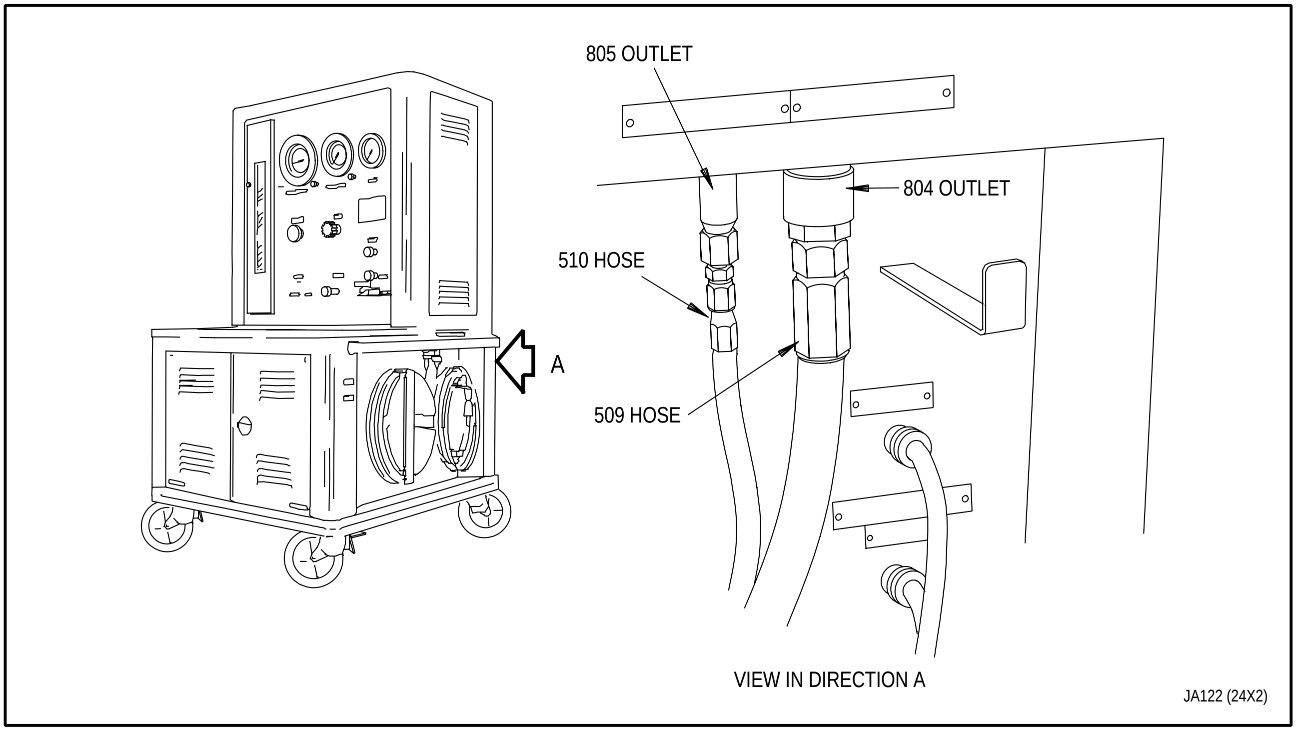


Figure 1. PWA 50003 Carbon Seal Tester - Hose Connection For Self-test

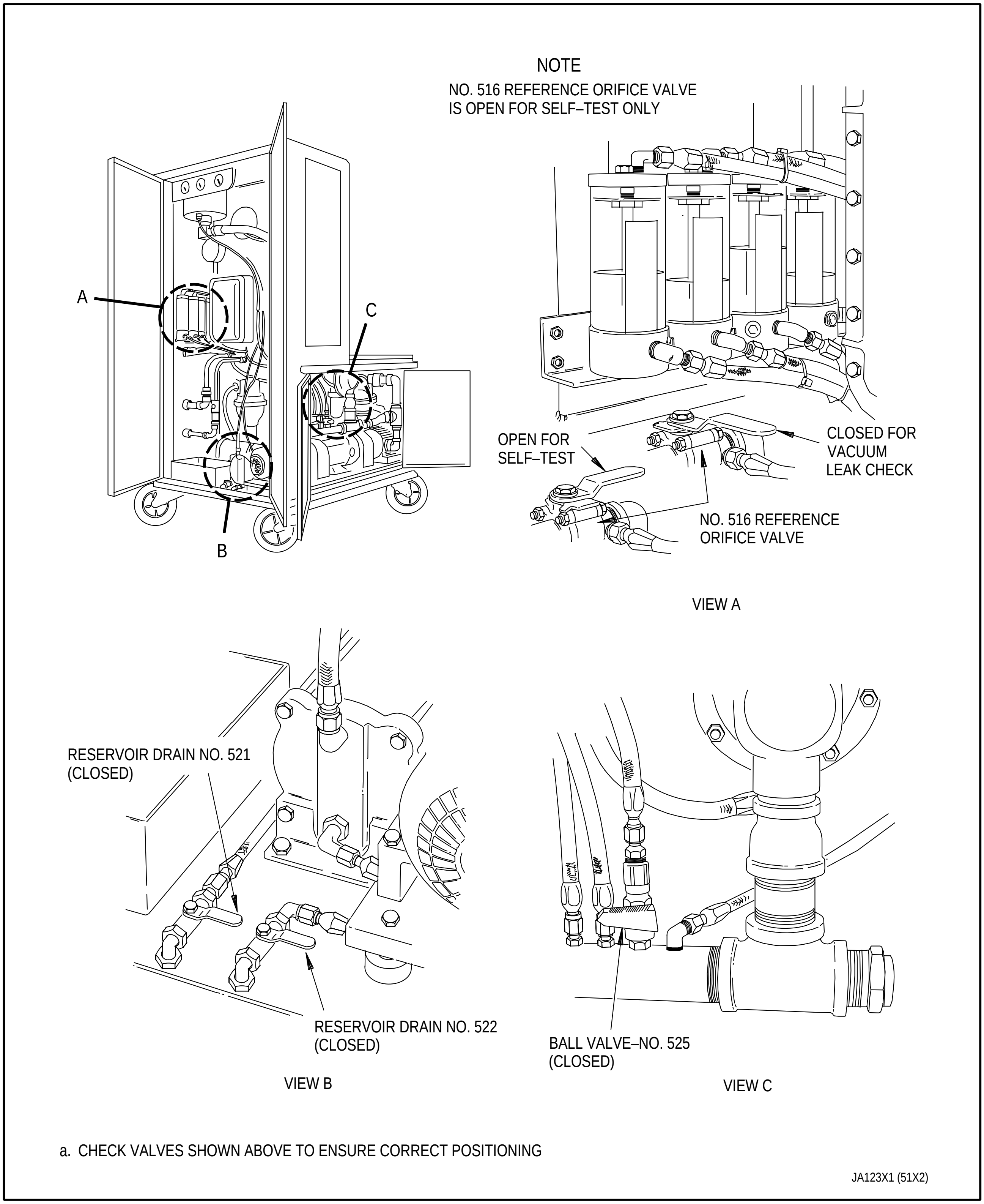


Figure 2. PWA 50003 Carbon Seal Tester - Operating Procedure (Sheet 1 of 5)

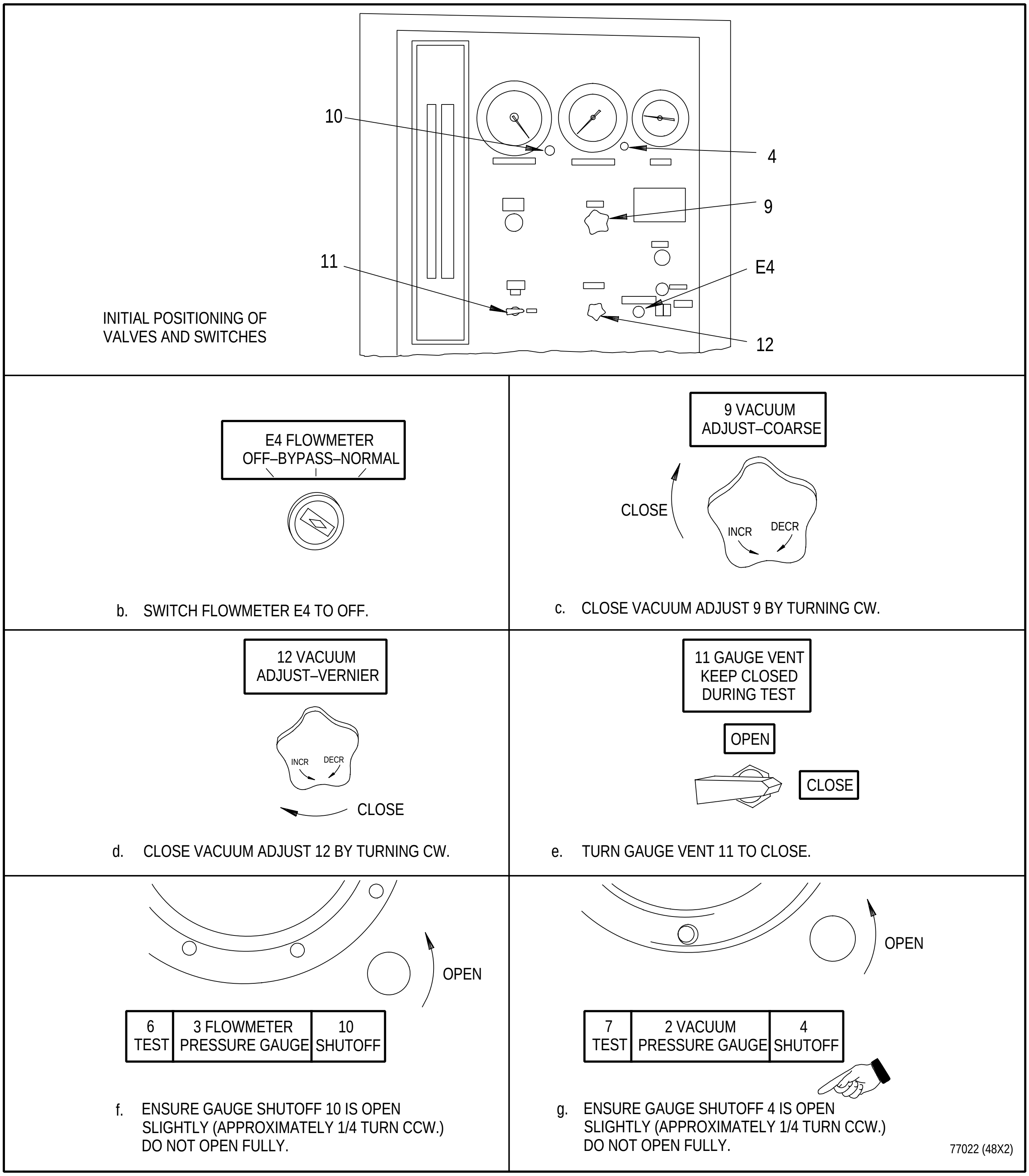


Figure 2. PWA 50003 Carbon Seal Tester - Operating Procedure (Sheet 2 of 5)

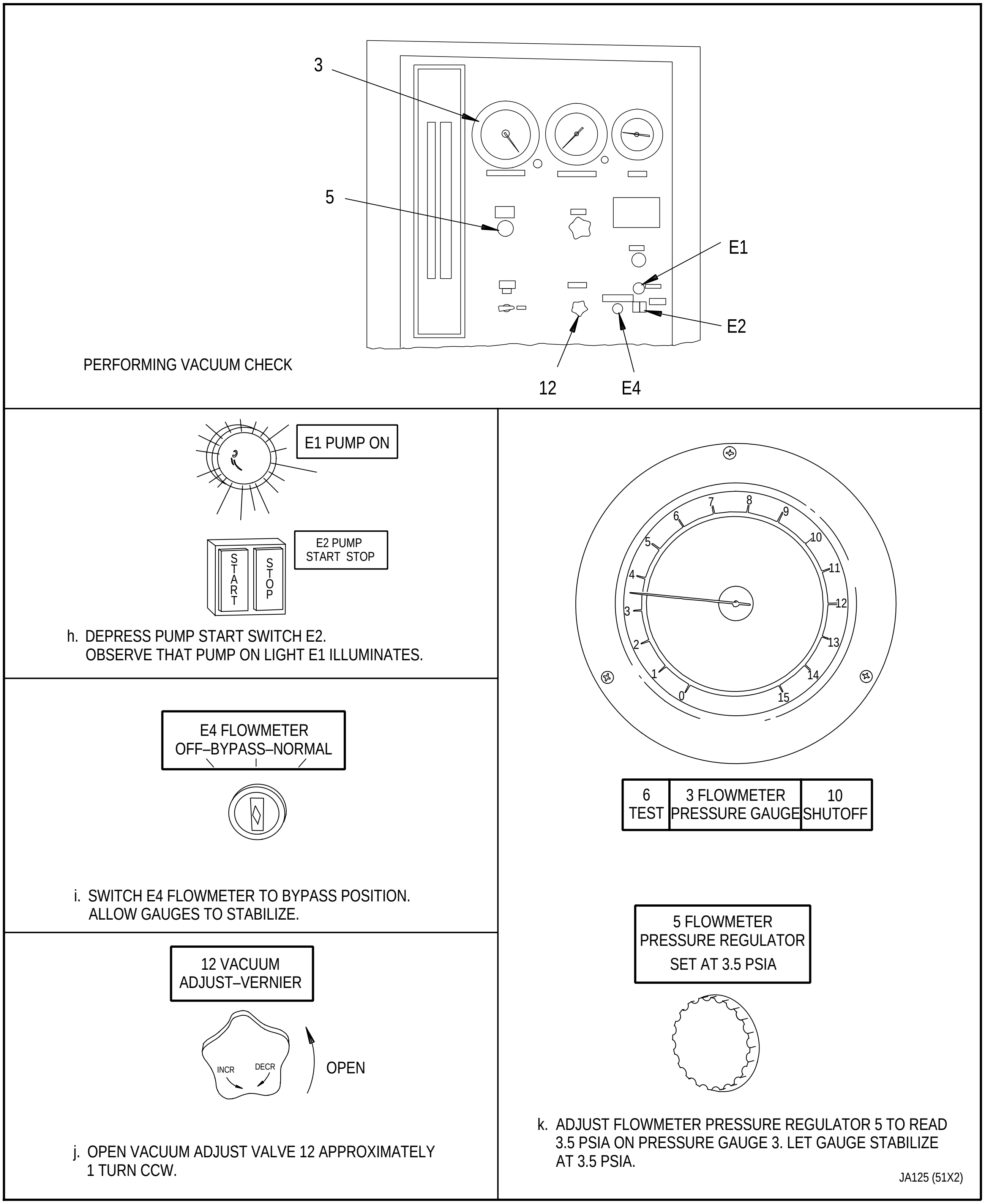


Figure 2. PWA 50003 Carbon Seal Tester - Operating Procedure (Sheet 3 of 5)

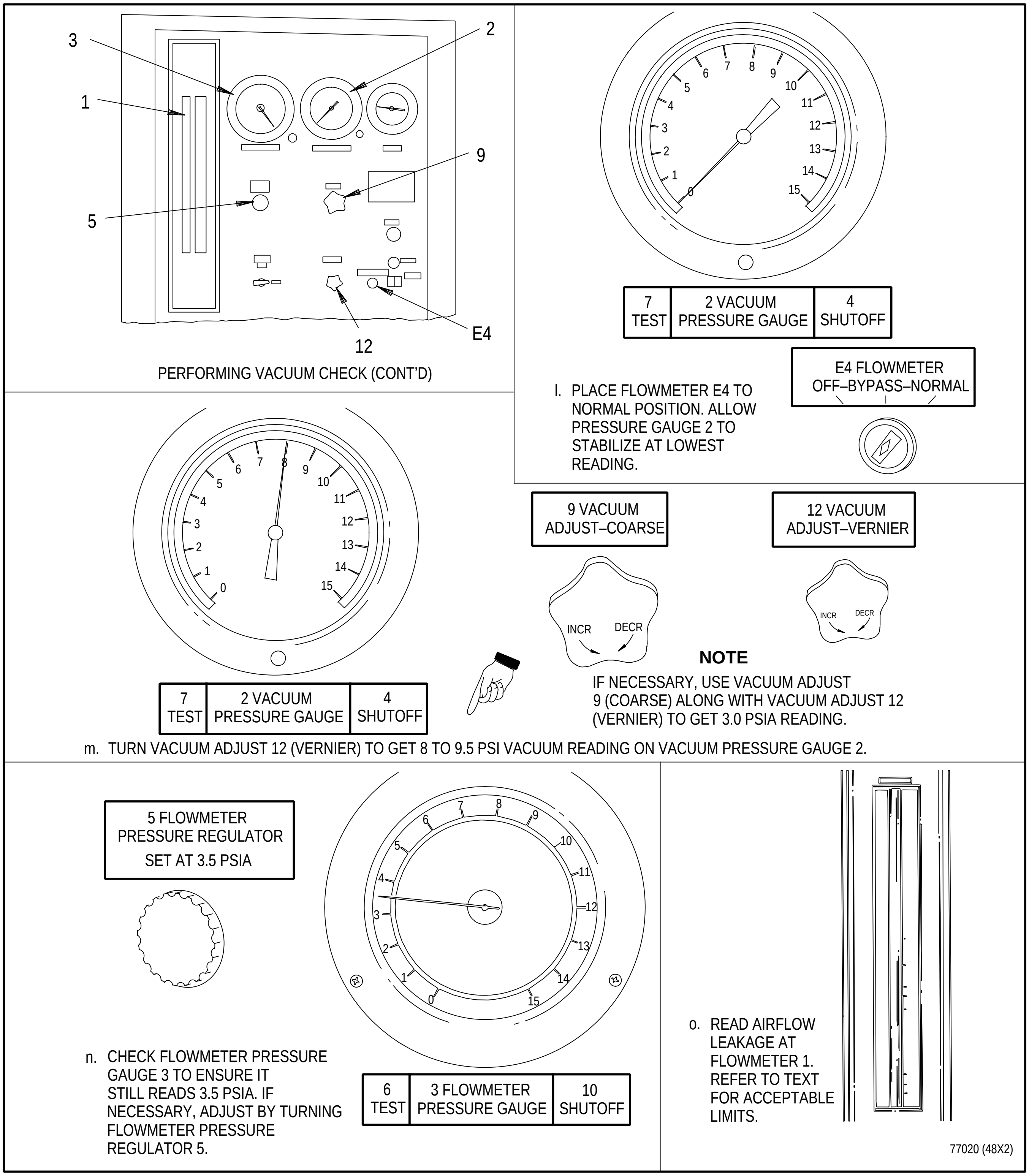


Figure 2. PWA 50003 Carbon Seal Tester - Operating Procedure (Sheet 4 of 5)

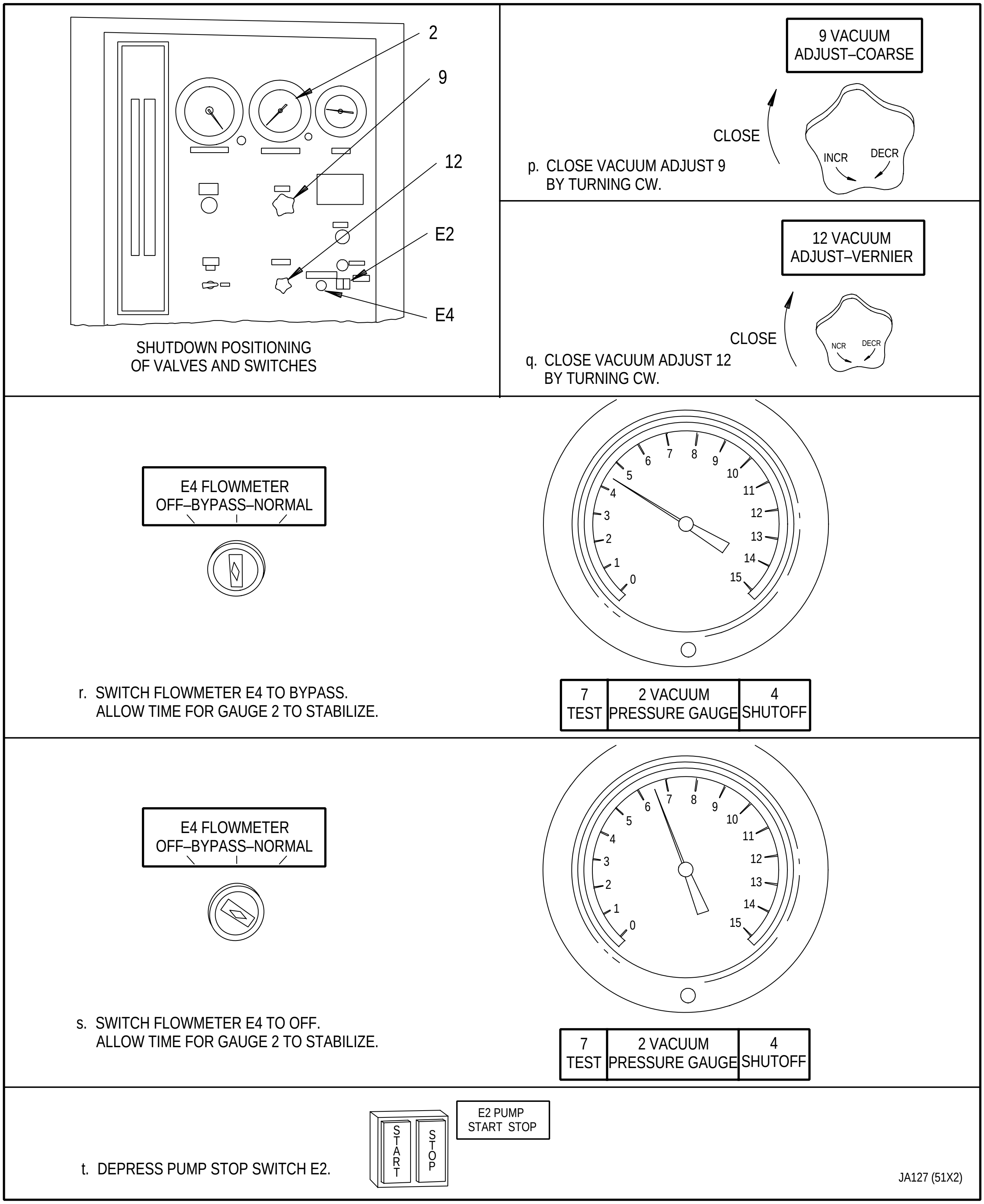


Figure 2. PWA 50003 Carbon Seal Tester - Operating Procedure (Sheet 5 of 5)

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

VACUUM LEAK CHECK
USING HABCO 1543003 VACUUM AIR FLOW CART —

GENERAL PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	17				

REFERENCE MATERIAL REQUIRED

Title	Number
Operating and Service Instructions, Drawings, and Parts Lists for Vacuum Air Flow Cart - Habco Model 1543003 - - - - - - - -	T.O. 33D4-6-782-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

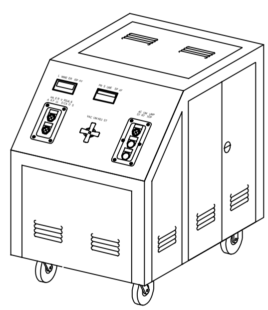
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Tool Nomenclature	Tool Number
2	Vacuum Leak Check Bearing Compartment - Using Habco 1543003 Vacuum Air Flow Cart	
	Cart, Vacuum air flow - - - - - - - - - - - - - -	Habco 1543003

ILLUSTRATED SUPPORT EQUIPMENT



HABCO 1543003 –C

Figure T1. Habco 1543003 Cart

1. INTRODUCTION.

a. This subordinate work package contains instructions for performing bearing compartment leak check using Habco 1543003 vacuum air flow cart, as referenced per applicable work package.

2. VACUUM LEAK CHECK BEARING COMPARTMENT - USING HABCO 1543003 VACUUM AIR FLOW CART.

(See Figure 1.)

a. Prepare cart as follows:

NOTE

- Refer to T.O. 33D4-6-782-1 for additional operation and service instructions for Habco 1543003 cart.
- Cart can operate on 220, 380, or 460 VAC, 3 phase, 50 or 60 Hz power.

(1) Ensure available facility power is within 10% of stated power.

CAUTION

Use of incorrect power cord can damage equipment.

(2) Select one of three marked power cords (provided with cart) which corresponds to available facility power.

(3) Connect proper power cord as follows:

(a) Loosen electrical receptacle cover screw(6, figure 1) on rear of cart, and open hinged cover.

WARNING

Failure to connect power cord in sequence described can result in serious injury or death to personnel.

(b) Insert power cord's female connector into male electrical receptacle(6) of cart.

(c) Move retaining lever left to lock power cord in place.

WARNING

Never remove power cord from cart before removing power cord from facility power receptacle. Failure to disconnect facility power before disconnecting power cord from cart can result in serious injury or death to personnel.

(d) Insert power cord's male connector into 220, 380, or 460 VAC, 3 phase, 50 or 60 Hz facility power receptacle.

b. Vacuum leak check bearing compartment as follows:

(1) Connect Habco 1503-4-411-4B-180 hose assembly (provided with cart) from absolute pressure sense port(7) to pressure sensing tap on appropriate connector or adapter. Refer to applicable work package for appropriate connector or adapter.

(2) Connect Habco 1503-16-411-16B-180 hose assembly (provided with cart) from vacuum inlet port(5) to vacuum supply port of appropriate connector or adapter. Refer to applicable work package for appropriate connector or adapter.

NOTE

Habco 1543003 vacuum air flow cart pressure display(1) indicates pressure in psia.

(3) Obtain and record absolute pressure reading for use in step b.(6). Absolute pressure reading shall be the same as local atmospheric pressure within ±0.10 psi. If local atmospheric pressure is measured in inches of mercury (in. Hg), convert in. Hg to psia as follows:

Local reading (in. Hg) x 0.4912 = psia

CAUTION

Vacuum pump may be damaged if following step is not complied with.

(4) Ensure vacuum adjust knob(8) is turned counterclockwise to mechanical stop.

(5) Start vacuum pump by depressing green vacuum pump start switch(3). Red vacuum pump ON indicator(2) will illuminate.

CAUTION

To prevent overpressure condition in bearing compartment, vacuum adjust knob(8) shall be turned slowly. A lag between turning vacuum adjust knob(8) and digital pressure display(1) may occur as vacuum pressure in bearing compartment is increased.

(6) While observing digital pressure display(1), turn vacuum adjust knob(8) slowly clockwise until display(1) reads an absolute pressure value of pressure reading obtained in step b.(3) minus 8.75psi±0.75psi.

NOTE

Temperature and atmospheric pressure effects on flowmeter readings are negligible.

(7) Read flow value indicated by flowmeter display(11) as actual vacuum air flow in pounds per hour (PPH). Air flow leakage shall not exceed specified value. Refer to applicable work package for specified flow leakage value.

c. Shut down cart as follows:

(1) Turn vacuum adjust knob(8) counterclockwise to mechanical stop.

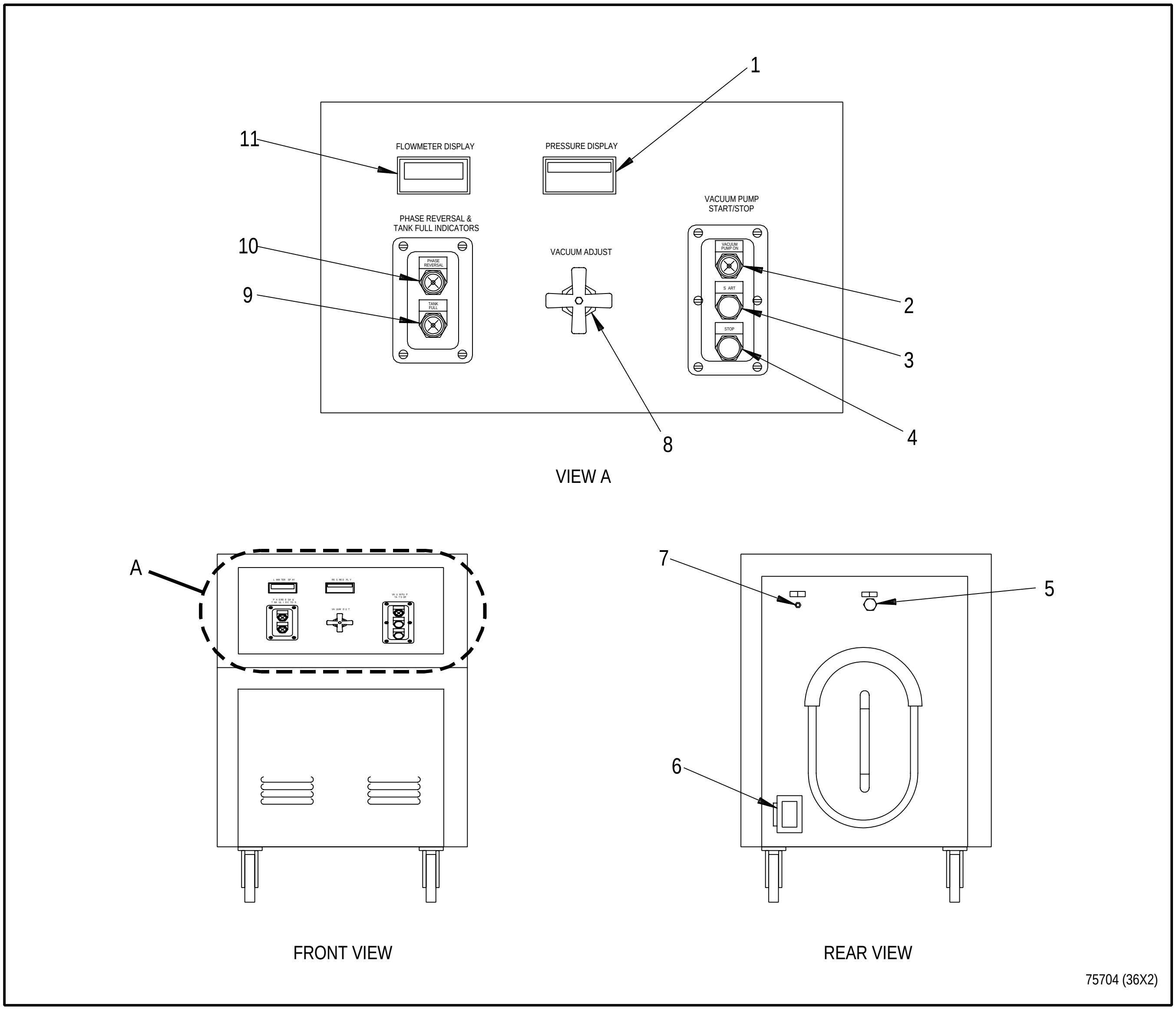
(2) Stop vacuum pump by depressing red vacuum pump stop switch(4). Red vacuum pump ON indicator(2) will extinguish.

WARNING

Failure to disconnect power cord in sequence described can result in serious injury or death to personnel.

(3) Remove power cord from facility power receptacle.

(4) Remove power cord from electrical receptacle(6) of cart.



1. Pressure display
2. Vacuum pump ON indicator (Red)
3. Vacuum pump start switch (Green)
4. Vacuum pump stop switch (Red)
5. Vacuum inlet port
6. Electrical receptacle, cover and screw
7. Absolute pressure sense port
8. Vacuum adjust knob
9. Tank full indicator (Red)
10. Phase reversal indicator (Red)
11. Flowmeter display

Figure 1. Habco 1543003 Vacuum Air Flow Cart - General Procedures

WORK PACKAGE

TECHNICAL PROCEDURES

AIR FLOW CHECK
USING PWA 50047 PNEUMATIC TEST SET

GENERAL PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	3	19	12 - 13	19
2	17	4 - 11	17	14	17

REFERENCE MATERIAL REQUIRED

Title	Number
Operation And Maintenance Instructions with Illustrated Parts Breakdown - PWA 50047 Pneumatic Test Set ------	T.O. 35D29-8-2-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

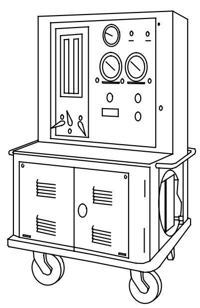
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Tool Nomenclature	Tool Number
2	AIR FLOW CHECK - USING PWA 50047 PNEUMATIC TEST SET	
	PNEUMATIC TEST SET ---------------------	PWA 50047

ILLUSTRATED SUPPORT EQUIPMENT



PWA 50047 –C

Figure T1. PWA 50047 Test Set

1. INTRODUCTION.

a. This work package contains instructions for performing bearing compartment air flow check. Refer to applicable manual work package.

2. AIR FLOW CHECK - USING PWA 50047 PNEUMATIC TEST SET.
(See Figures 1 and 2.)

CAUTION

To avoid oil foaming and oil pressure loss, use only specified lubricants on packings. Avoid using lubricants containing silicone.

NOTE

To ensure proper operation, perform self-test each time PWA 50047 pneumatic test set is used.

a. Perform self-test on PWA 50047 test set. See figure 1. Use only MIL-L-7808 lubricating oil or VV-P-236 petrolatum on packings. Refer to T.O. 35D29-8-2-1 for further operating and service instructions.

b. Install tooling. Refer to applicable work package.

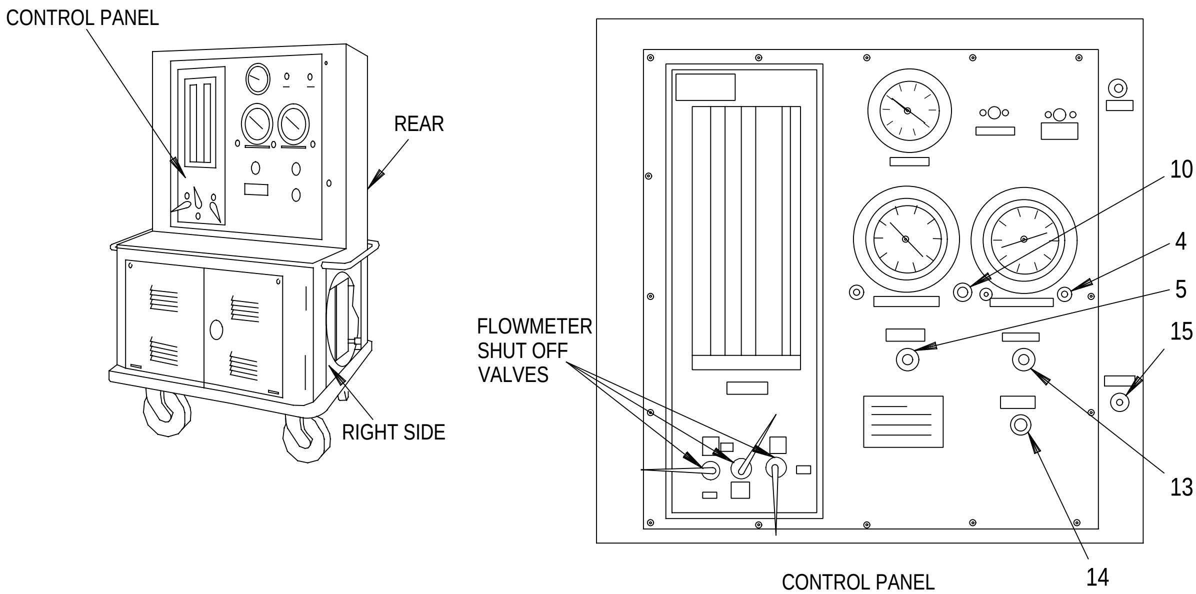
c. Perform air flow check. (See figure 2.)

(1) Apply 10 psig pressure.

(2) Measure rate of air flow. Air flow shall be within limits specified in applicable work package.

d. Turn off PWA 50047 test set.

e. Remove tooling.

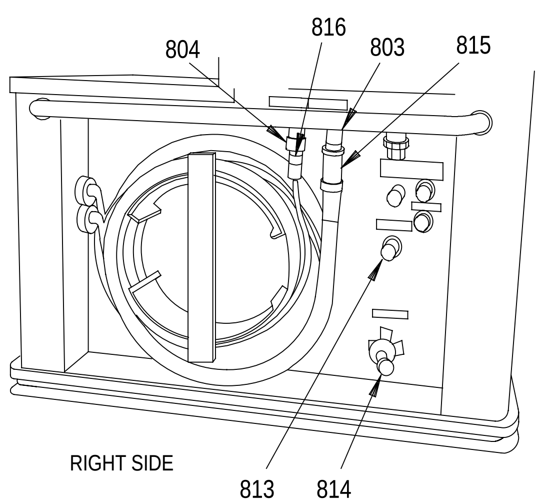


a. POSITION VALVES ON CONTROL PANEL AS FOLLOWS:

- PUSH IN 15 EMERGENCY STOP.
- PUSH IN 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- ENSURE THREE FLOWMETER SHUT OFF VALVES ARE IN CLOSED POSITION.
- OPEN 5 FLOWMETER PRESSURE REGULATOR VALVE 12 TO 14 TURNS CCW.
- ENSURE 10 FLOWMETER PRESSURE GAGE SHUT OFF IS OPEN SLIGHTY (APPROXIMATELY 1/4 TURN CCW). DO NOT OPEN FULLY.
- ENSURE 4 REGULATED AIR SUPPLY PRESSURE GAGE SHUT OFF IS OPEN SLIGHTY (APPROXIMATELY 1/4 TURN CCW). DO NOT OPEN FULLY.
- PULL OUT 15 EMERGENCY STOP.

b. POSITION HOSES, ORIFICE, AND VALVE ON RIGHT SIDE OF TESTER AS FOLLOWS:

- PULL OPEN 813 INTERNAL LEAKAGE TEST SHUT OFF VALVE.
- CONNECT HOSE 816 TO 804 INTERNAL LEAKAGE TEST.
- CONNECT HOSE 815 TO 803 INTERNAL LEAKAGE TEST.
- CONNECT HOSE 814 TO 80–110 PSIG, 30 SCFM AIR SUPPLY, WITH 35°F (17°C) DEW POINT.



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Figure 1. PWA 50047 Pneumatic Test Set - Self-Test (Sheet 1 of 5)

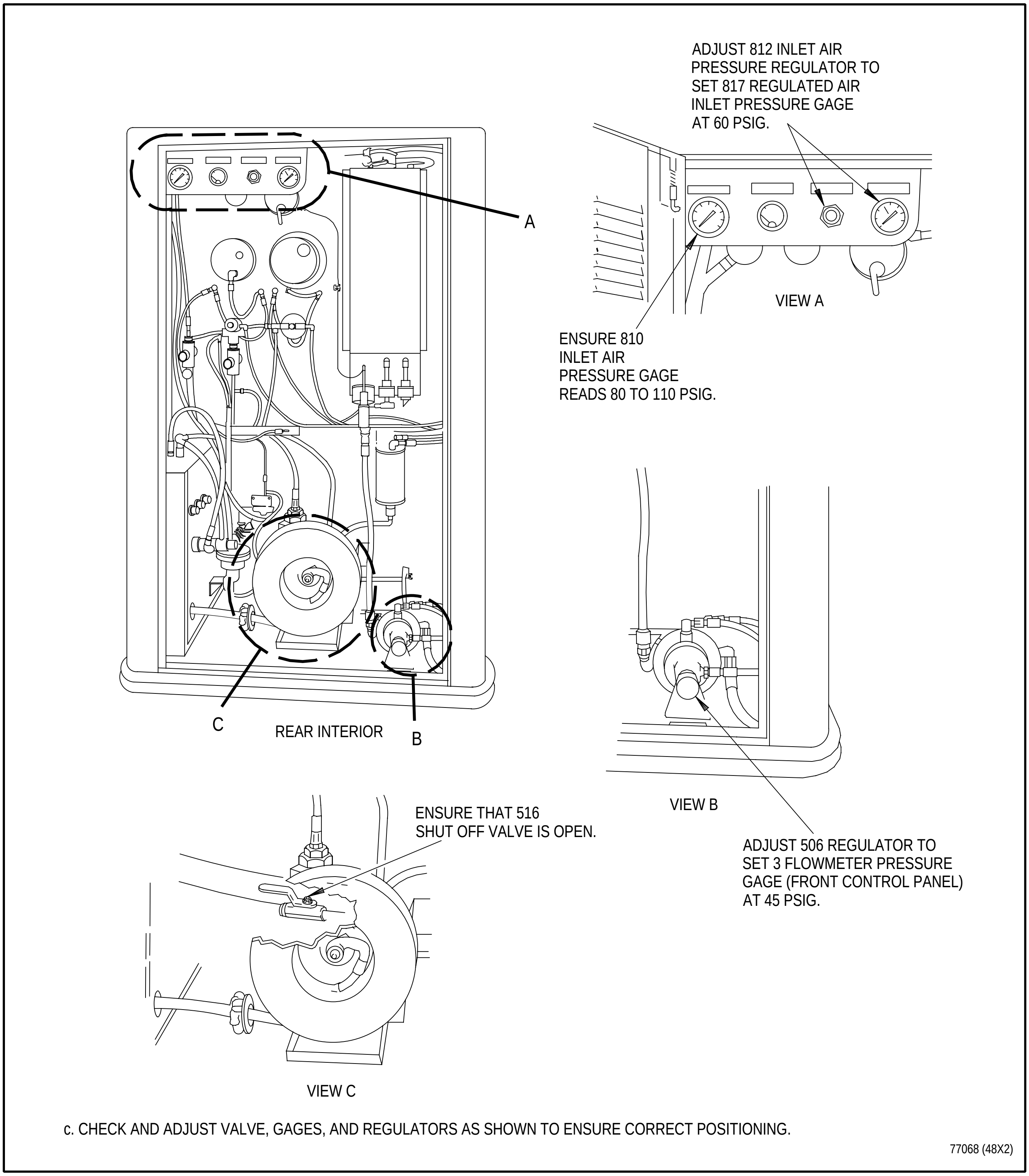
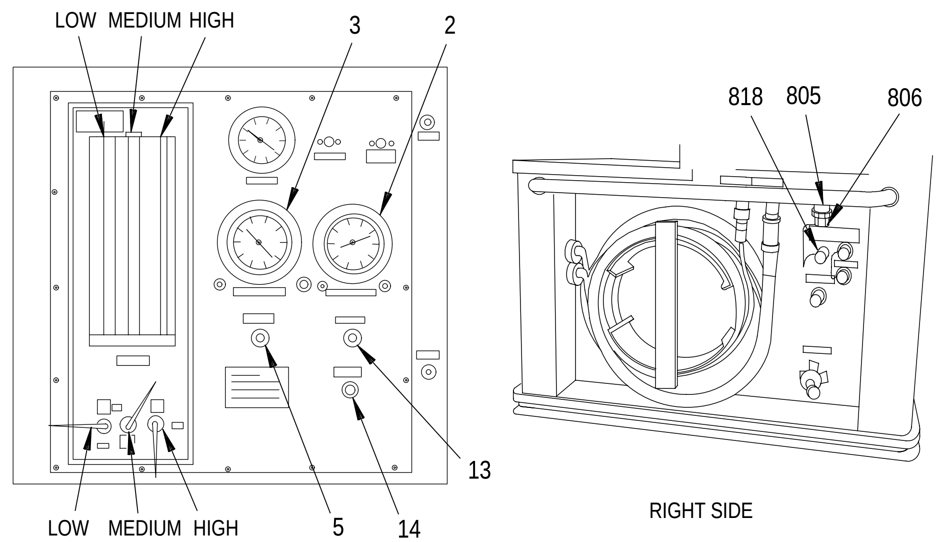


Figure 1. PWA 50047 Pneumatic Test Set - Self-Test (Sheet 2 of 5)



d. MAKE FINE ADJUSTMENT TO GET 50 PSIA READING ON 3 FLOWMETER PRESSURE GAGE BY TURNING 5 FLOWMETER REGULATOR.

e. TEST LOW RANGE FLOWMETER AS FOLLOWS:

CAUTION

OPEN FLOWMETER SHUT OFF VALVES SLOWLY.
OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS FLOWMETER TUBES.

- REMOVE 806 REFERENCE ORIFICE FROM HOLDER 818, AND INSTALL ON 805 INTERNAL LEAKAGE TEST FITTING (RIGHT SIDE).
- TURN REGULATOR 13 CCW 8 TO 10 TURNS FROM FULL CW POSITION.
- PULL OUT 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- SLOWLY OPEN HIGH RANGE FLOWMETER SHUT OFF VALVE. (RIGHT VALVE, CONTROL PANEL).
- SLOWLY OPEN MEDIUM RANGE FLOWMETER SHUT OFF VALVE (CENTER VALVE), THEN CLOSE HIGH RANGE FLOWMETER SHUT OFF VALVE (RIGHT VALVE).
- SLOWLY OPEN LOW RANGE FLOWMETER SHUT OFF VALVE (LEFT VALVE), THEN CLOSE MEDIUM RANGE FLOWMETER SHUT OFF VALVE (CENTER VALVE).
- ADJUST 13 REGULATED AIR SUPPLY PRESSURE REGULATOR TO ATTAIN READING OF 10.0 PSIG ON 2 REGULATED AIR SUPPLY PRESSURE GAGE.
- ENSURE 3 FLOWMETER PRESSURE GAGE STILL INDICATES 50.0 PSI. IF NECESSARY, ADJUST USING 5 FLOWMETER PRESSURE REGULATOR.
- READ AIRFLOW ON LOW RANGE FLOWMETER (LEFT TUBE).

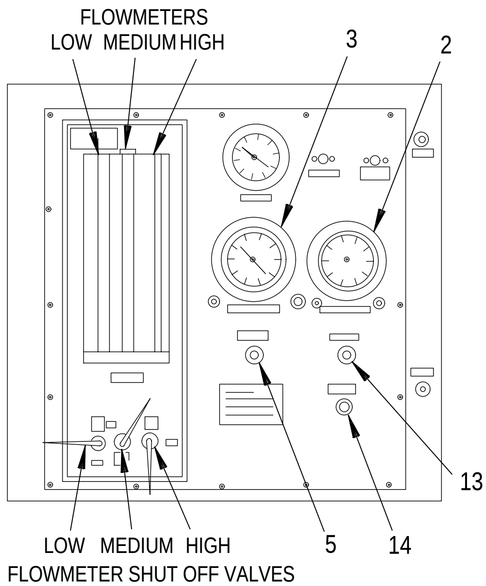
READING SHALL BE:

LOW	HIGH	BAROMETRIC PRESSURE
0.78	0.86	15.0 TO 14.5
0.74	0.85	14.5 TO 14.0
0.72	0.82	14.0 TO 13.5
0.69	0.79	13.5 TO 13.0
0.66	0.76	13.0 TO 12.5
0.64	0.73	12.5 TO 12.0

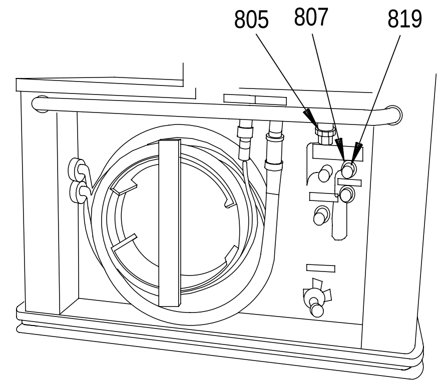
- CLOSE LOW RANGE FLOWMETER SHUT OFF VALVE (LEFT VALVE).
- PUSH IN 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- REMOVE 806 REFERENCE ORIFICE FROM 805 INTERNAL LEAKAGE TEST FITTING. STORE ORIFICE IN HOLDER 818 (RIGHT SIDE).

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Figure 1. PWA 50047 Pneumatic Test Set - Self-Test (Sheet 3 of 5)



CONTROL PANEL



RIGHT SIDE

f. TEST MEDIUM RANGE FLOWMETER AS FOLLOWS:

CAUTION

OPEN FLOWMETER SHUT OFF VALVES SLOWLY. OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS FLOWMETER TUBES.

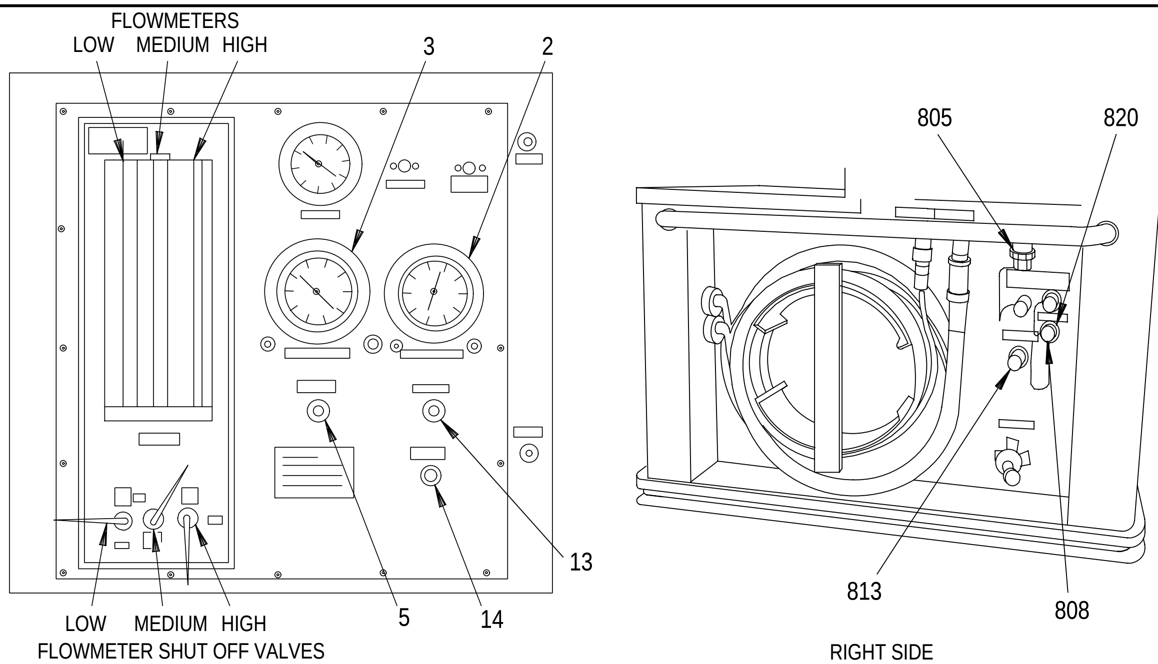
- REMOVE 807 REFERENCE ORIFICE FROM HOLDER 819. INSTALL 807 REFERENCE ORIFICE ON 805 INTERNAL LEAKAGE TEST FITTING (RIGHT SIDE).
- TURN REGULATOR 13 CCW 8 TO 10 TURNS FROM FULL CW POSITION.
- PULL OUT 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- SLOWLY OPEN HIGH RANGE FLOWMETER SHUT OFF VALVE (RIGHT VALVE).
- SLOWLY OPEN MEDIUM RANGE FLOWMETER SHUT OFF VALVE (CENTER VALVE), THEN CLOSE HIGH RANGE FLOWMETER SHUT OFF VALVE (RIGHT VALVE).
- ADJUST 13 REGULATED AIR SUPPLY PRESSURE REGULATOR TO ATTAIN READING OF 10.0 PSIG ON 2 REGULATED AIR SUPPLY PRESSURE GAGE.
- ENSURE 3 FLOWMETER PRESSURE GAGE STILL INDICATES 50.0 PSIG. IF NECESSARY, ADJUST USING 5 FLOWMETER PRESSURE REGULATOR.
- READ AIRFLOW ON MEDIUM RANGE FLOWMETER (CENTER TUBE).

READING SHALL BE:	LOW	HIGH	BAROMETRIC PRESSURE
	7.4	8.1	15.0 TO 14.5
	7.0	8.0	14.5 TO 14.0
	6.8	7.7	14.0 TO 13.5
	6.5	7.5	13.5 TO 13.0
	6.3	7.1	13.0 TO 12.5
	6.0	6.9	12.5 TO 12.0

- CLOSE MEDIUM RANGE FLOWMETER SHUT OFF VALVE (CENTER VALVE).
- PUSH IN 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- REMOVE 807 REFERENCE ORIFICE FROM 805 INTERNAL LEAKAGE TEST FITTING. STORE ORIFICE IN HOLDER 819 (RIGHT SIDE).

77070 (48X2)

Figure 1. PWA 50047 Pneumatic Test Set - Self-Test (Sheet 4 of 5)



CONTROL PANEL

g. TEST HIGH RANGE FLOWMETER AS FOLLOWS:

CAUTION

OPEN FLOWMETER SHUT OFF VALVES SLOWLY. OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS FLOWMETER TUBES.

- REMOVE 808 REFERENCE ORIFICE FROM HOLDER 820. INSTALL ORIFICE ON 805 INTERNAL LEAKAGE TEST FITTING (RIGHT SIDE).
- TURN REGULATOR 13 CCW 8 TO 10 TURNS FROM FULL CW POSITION.
- PULL OUT 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- SLOWLY OPEN HIGH RANGE FLOWMETER SHUT OFF VALVE (RIGHT VALVE).
- ADJUST 13 REGULATED AIR SUPPLY PRESSURE REGULATOR TO ATTAIN READING OF 10.0 PSIG ON 2 REGULATED AIR SUPPLY PRESSURE GAGE.
- ENSURE 3 FLOWMETER PRESSURE GAGE STILL INDICATES 50.0 PSIA. IF NECESSARY, ADJUST USING 5 FLOWMETER PRESSURE REGULATOR.
- READ AIRFLOW ON HIGH RANGE FLOWMETER (RIGHT TUBE).

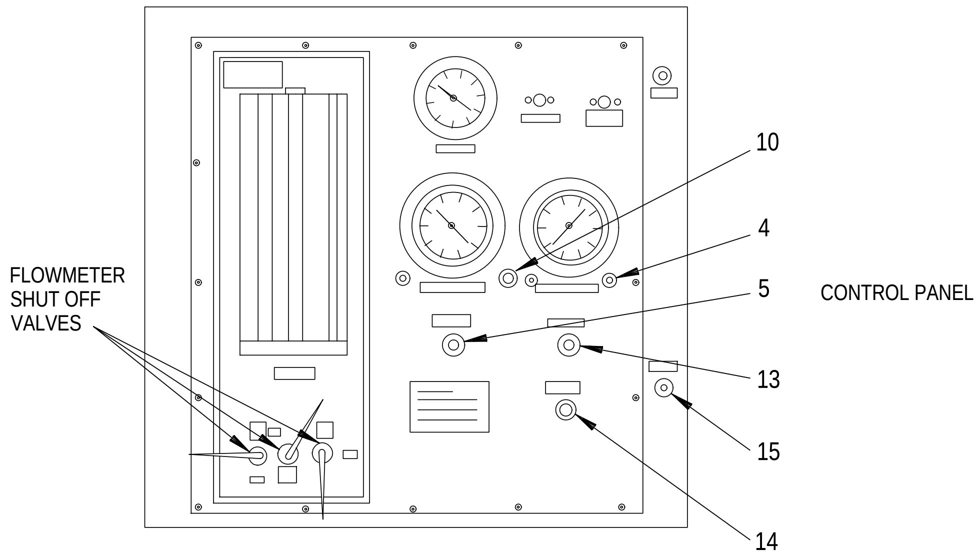
READING SHALL BE:

LOW	HIGH	BAROMETRIC PRESSURE
70.0	76.0	15.0 TO 14.5
66.7	75.0	14.5 TO 14.0
64.3	72.4	14.0 TO 13.5
61.9	69.8	13.5 TO 13.0
59.5	67.2	13.0 TO 12.5
57.1	64.6	12.5 TO 12.0

- CLOSE HIGH RANGE FLOWMETER SHUT OFF VALVE (RIGHT VALVE).
- PUSH IN 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- REMOVE 808 REFERENCE ORIFICE FROM 805 INTERNAL LEAKAGE TEST FITTING. STORE ORIFICE ON HOLDER 820 (RIGHT SIDE).
- PUSH IN 813 INTERNAL LEAKAGE TEST SHUT OFF VALVE (RIGHT SIDE).

77071 (48X2)

Figure 1. PWA 50047 Pneumatic Test Set - Self-Test (Sheet 5 of 5)

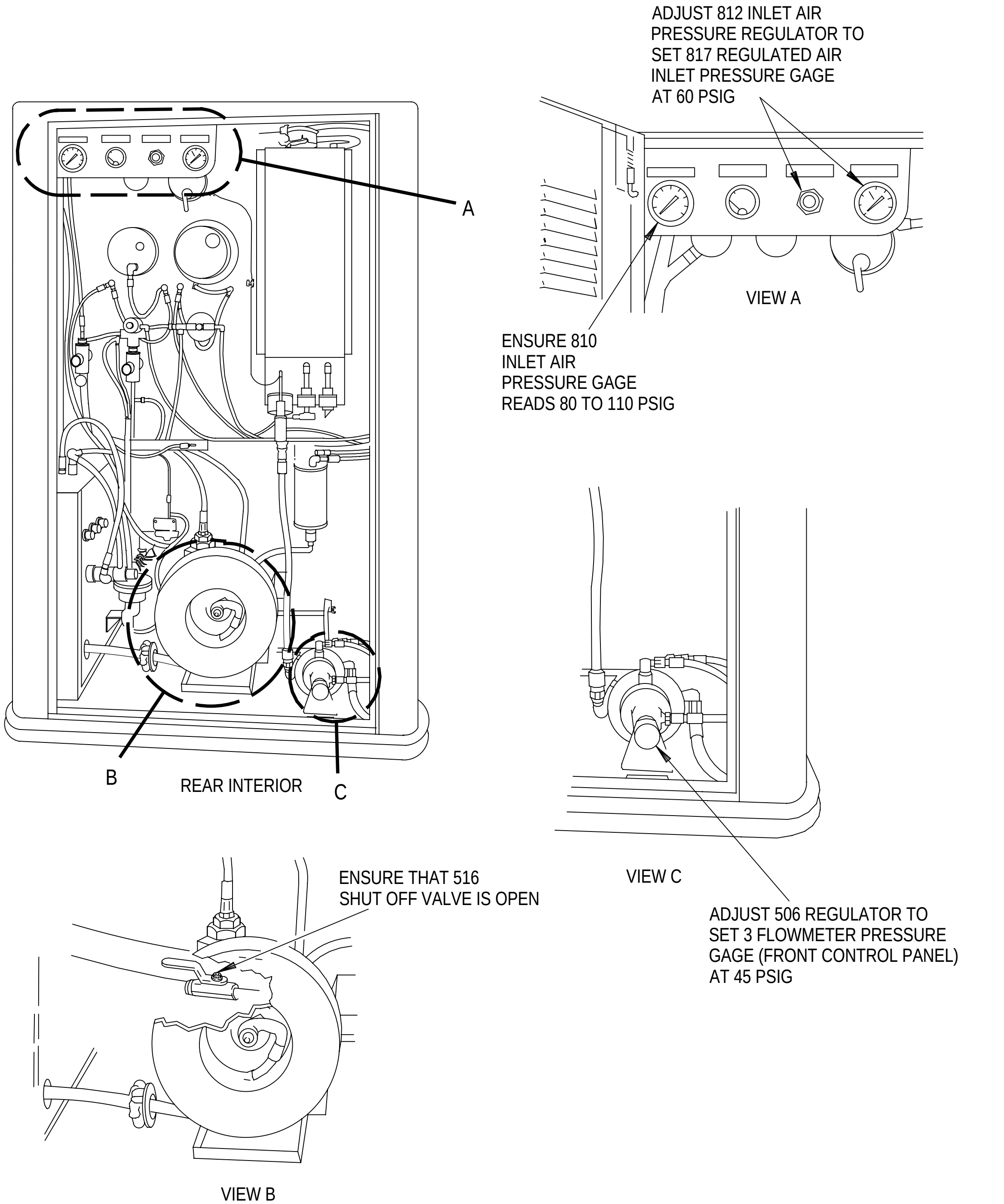


a. POSITION VALVES ON CONTROL PANEL AS FOLLOWS:

- PUSH IN 15 EMERGENCY STOP.
- PUSH IN 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- ENSURE THREE FLOWMETER SHUT OFF VALVES ARE IN CLOSED POSITION.
- OPEN 5 FLOWMETER PRESSURE REGULATOR VALVE 8 TO 10 TURNS CCW.
- TURN REGULATOR 13 CCW 8 TO 10 TURNS FROM FULL CW POSITION.
- ENSURE 10 FLOWMETER PRESSURE GAGE SHUT OFF IS OPEN SLIGHTLY (APPROXIMATELY 1/4 TURN CCW). DO NOT OPEN FULLY.
- ENSURE 4 REGULATED AIR SUPPLY PRESSURE GAGE SHUT OFF IS OPEN SLIGHTLY (APPROXIMATELY 1/4 TURN CCW). DO NOT OPEN FULLY.
- PULL OUT 15 EMERGENCY STOP.

77072 (36X2)

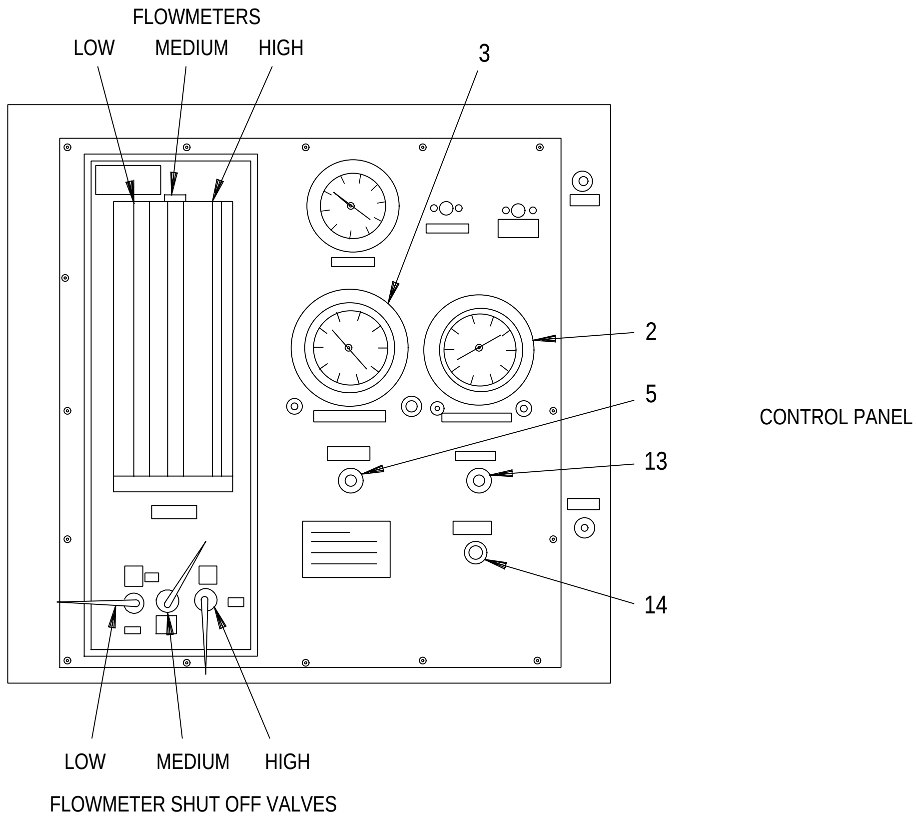
Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 1 of 6)



b. CHECK AND ADJUST VALVE, GAGES, AND REGULATORS AS SHOWN TO ENSURE CORRECT POSITIONING.

77073 (48X2)

Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 2 of 6)



CAUTION

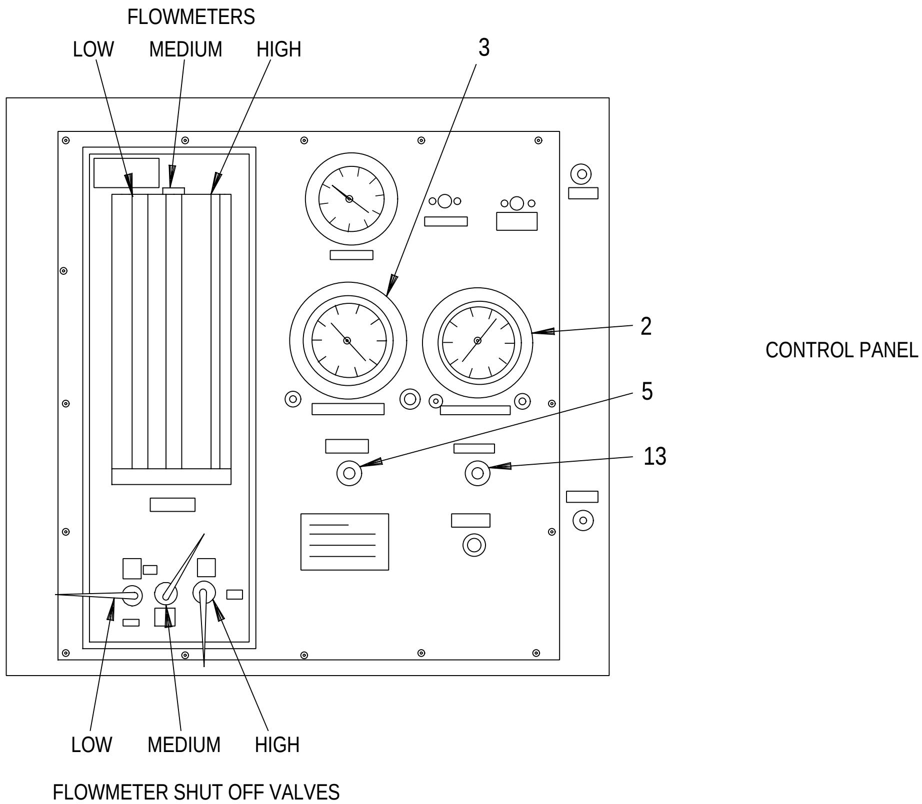
OPEN FLOWMETER SHUT OFF VALVES SLOWLY. OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS.

c. PERFORM AIRFLOW CHECK ON HIGH RANGE FLOWMETER (RIGHT TUBE) AS FOLLOWS:

- SLOWLY OPEN FLOWMETER SHUT OFF VALVE FOR HIGH RANGE FLOWMETER (RIGHT TUBE) BY TURNING CCW.
- PULL OUT 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- SLOWLY ADJUST REGULATOR 13 TO ATTAIN A READING OF 10 PSIG ON PRESSURE GAGE 2.
- IF 10.0 PSIG CANNOT BE ATTAINED ON 2 REGULATED AIR SUPPLY PRESSURE GAGE, AIRFLOW THROUGH PART IS IN EXCESS OF 10.0 PSIG.
- IF 10.0 PSIG IS ATTAINED ON 2 REGULATED AIR SUPPLY PRESSURE GAGE, ADJUST 5 FLOWMETER PRESSURE REGULATOR TO ATTAIN 50.0 PSIA ON 3 FLOWMETER PRESSURE GAGE, AND RECORD FLOW INDICATION FROM HIGH RANGE FLOWMETER (RIGHT TUBE).

77074 (48X2)

Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 3 of 6)



d. IF NO FLOW INDICATION ON HIGH RANGE FLOWMETER, OR IF FLOW INDICATION IS BELOW 15.0 PHR AND A MORE PRECISE READING IS REQUIRED:

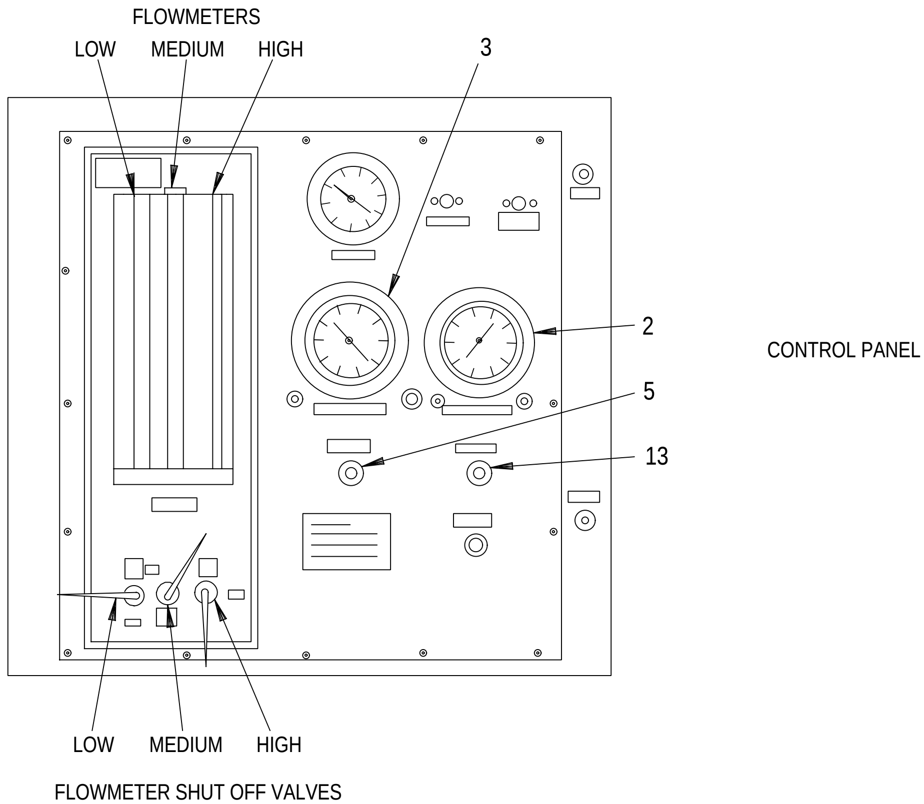
CAUTION

OPEN FLOWMETER SHUT OFF VALVES SLOWLY. OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS.

- SLOWLY OPEN FLOWMETER SHUT OFF VALVE FOR MEDIUM RANGE FLOWMETER (CENTER TUBE), AND CLOSE FLOWMETER SHUT OFF VALVE FOR HIGH RANGE FLOWMETER (RIGHT TUBE).
- SLOWLY ADJUST REGULATOR 13 TO ATTAIN A READING OF 10 PSIG ON PRESSURE GAGE 2.
- ADJUST FLOWMETER PRESSURE REGULATOR 5 TO MAINTAIN 50.0 PSIA ON 3 FLOWMETER PRESSURE GAGE.
- RECORD FLOW FROM MEDIUM RANGE FLOWMETER (CENTER TUBE).

81795 (36X2)

Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 4 of 6)



e. IF NO FLOW INDICATION ON MEDIUM RANGE FLOWMETER, OR IF FLOW INDICATION IS BELOW 2.0 PHR AND A MORE PRECISE READING IS REQUIRED:

CAUTION

OPEN FLOWMETER SHUT OFF VALVES SLOWLY. OPENING VALVES QUICKLY COULD CAUSE A HIGH FLOW TO BREAK GLASS.

- SLOWLY OPEN FLOWMETER SHUT OFF VALVE FOR LOW RANGE FLOWMETER (LEFT TUBE), AND CLOSE FLOWMETER SHUT OFF VALVE FOR MEDIUM RANGE FLOWMETER (CENTER TUBE).
- SLOWLY ADJUST REGULATOR 13 TO ATTAIN A READING OF 10 PSIG ON PRESSURE GAGE 2.
- ADJUST 5 FLOWMETER PRESSURE REGULATOR TO MAINTAIN 50 PSIA ON 3 FLOWMETER PRESSURE GAGE.
- RECORD FLOW INDICATION FROM LOW RANGE FLOWMETER (LEFT TUBE).

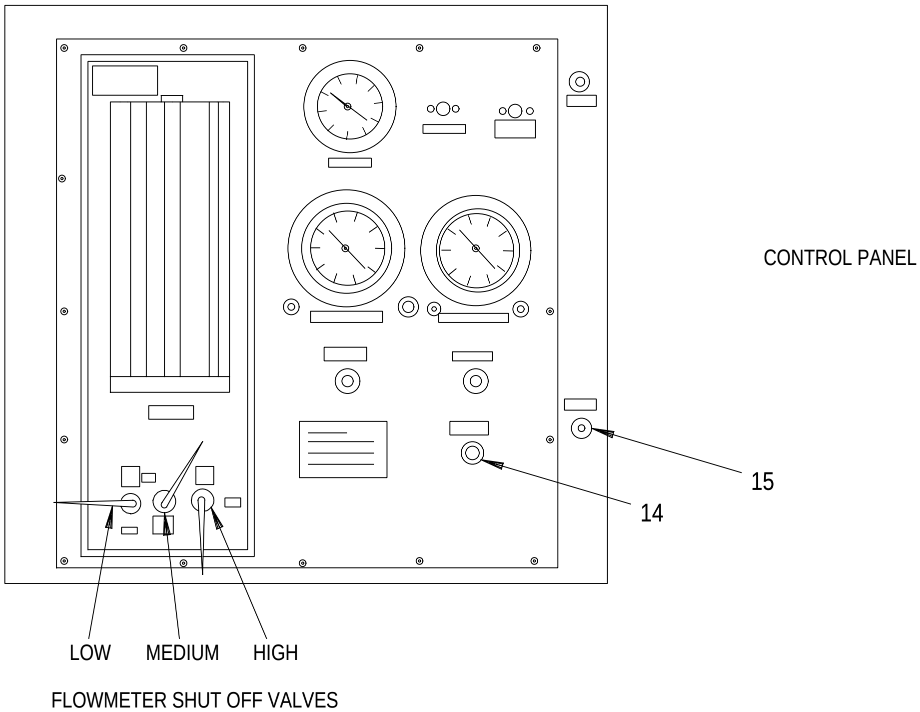
CAUTION

DO NOT LEAVE FLOWMETER SHUT OFF VALVE OPEN IF THERE IS NO INDICATION OF AIRFLOW ON LOW RANGE FLOWMETER. IF FLOWMETER SHUT OFF VALVE IS LEFT OPEN AND NO AIR IS FLOWING, REGULATED AIR SUPPLY MAY GRADUALLY INCREASE, RUPTURING BURST DISC ASSEMBLY.

- IF NO FLOW IS INDICATED ON LOW RANGE FLOWMETER (LEFT TUBE) FLOW RATE IS LESS THAN 0.15 PHR. TO ENSURE AIR IS FLOWING, CLOSE ALL FLOWMETER SHUT OFF VALVES, TRAPPING REGULATED AIR SUPPLY AT 10.0 PSIG. PRESSURE DECAY OF MORE THAN 1.0 PSI ON 3 FLOWMETER PRESSURE GAGE, AFTER FIVE MINUTES, INDICATES AIR FLOW.

81796 (48X2)

Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 5 of 6)



f. SHUT DOWN PWA 50047 PNEUMATIC TEST SET AS FOLLOWS:

- CLOSE FLOWMETER SHUT OFF VALVES.
- PUSH (CLOSE) 14 REGULATED AIR SUPPLY SHUT OFF VALVE.
- PUSH (CLOSE) 15 EMERGENCY STOP VALVE.

77077 (36X2)

Figure 2. PWA 50047 Pneumatic Test Set - Operating Instructions (Sheet 6 of 6)

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

AIR FLOW CHECK
USING HABCO 1093005 PORTABLE AIR FLOW CHECKER —

GENERAL PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	4	19	5	17
2 - 3	17			6 Blank	17

REFERENCE MATERIAL REQUIRED

Title	Number
Operating and Maintenance Instruction Manual for Portable Air Flow Checker - Habco Model 1093005 -----------	T.O. 33D4-6-781-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

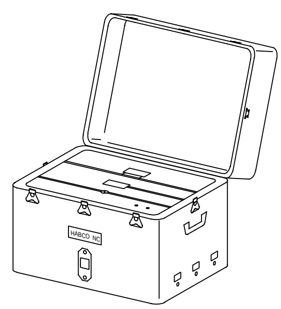
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Tool Nomenclature	Tool Number
2	Air Flow Check Of Bearing Compartment - Using Habco 1093005 Portable Air Flow Checker	
	Checker, Portable air flow ----------------	Habco 1093005

ILLUSTRATED SUPPORT EQUIPMENT



HABCO 1093005 –C

Figure T1. Habco 1093005 Checker

1. INTRODUCTION.

This subordinate work package contains instructions for performing bearing compartment air flow check using Habco 1093005 portable air flow checker, as referenced per applicable work package.

2. AIR FLOW CHECK OF BEARING COMPARTMENT - USING HABCO 1093005 PORTABLE AIR FLOW CHECKER.

(See Figure 1.)

a. Prepare checker as follows:

NOTE

- Refer to T.O. 33D4-6-781-1 for additional operation and service instructions for Habco 1093005 checker.
- Habco 1093005 checker can operate on 115 or 230 VAC, single phase, 50 or 60 Hz power.
- Power cord (provided with checker) is equipped with 115 VAC connector.

(1) Replace 115 VAC connector with 230 VAC connector if checker is to be connected to 230 VAC facility power outlet.

WARNING

Failure to connect power cord in sequence described can result in serious injury or death to personnel.

(2) Insert power cord's female connector into male electrical receptacle(10, figure 1) of checker.

WARNING

Never remove power cord from checker before removing power cord from facility power receptacle. Failure to disconnect facility power before disconnecting power cord from checker can result in serious injury or death to personnel.

(3) Insert power cord's male connector into 115 or 230 VAC, single phase, 50 or 60 Hz facility power receptacle.

b. Air flow check bearing compartment as follows:

CAUTION

Checker may be damage if following step is not complied with.

(1) Ensure pressure adjust knob(3) is turned counterclockwise until regulating spring pressure is absent.

(2) Attach locally manufactured hose with AN-8 JIC hose end to shop air inlet port(9).

WARNING

Personal injury may occur if specified air pressure limit is exceeded.

CAUTION

Damage to checker may occur if specified air pressure limit is exceeded.

(3) Attach opposite end of locally manufactured hose to facility dry air supply, not to exceed 200 PSIG.

(4) Connect Habco 821-0606-8B-8B-08-18 (18 inch long) jumper hose assembly (provided with checker) from regulated air outlet port(11) to flowmeter inlet port(12).

(5) Connect Habco 821-0606-8B-8B-08-120 (120 inch long) hose assembly (provided with checker) from flowmeter air outlet port(7) to appropriate connector or adapter. Refer to applicable work package for appropriate connector or adapter.

(6) Connect Habco 821-0606-4B-4B-04-120 (120 inch long) hose assembly (provided with checker) from pressure tap port(8) to appropriate connector or adapter. Refer to applicable work package for appropriate connector or adapter.

(7) Toggle power ON/OFF switch(5) to On position and allow 10 to 15 minutes for checker to warm and stabilize.

NOTE

A few plus/minus counts are not significant.

(8) Ensure digital pressure display(2) reads 000.0 and digital flowmeter display(1) reads 00.00.

CAUTION

To prevent overpressure condition in bearing compartment, pressure adjust knob(3) shall be turned slowly. A lag between turning pressure adjust knob(3) and digital pressure display(2) may occur as air pressure in bearing compartment is increased.

(9) While observing digital pressure display(2), turn pressure adjust knob(3) slowly clockwise until pressure display(2) reads 10 psig.

(10) Read flow value indicated by digital flowmeter display(1) as air flow in pounds per hour (PPH). Air flow leakage shall not exceed specified value. Refer to applicable work package for specified flow leakage value.

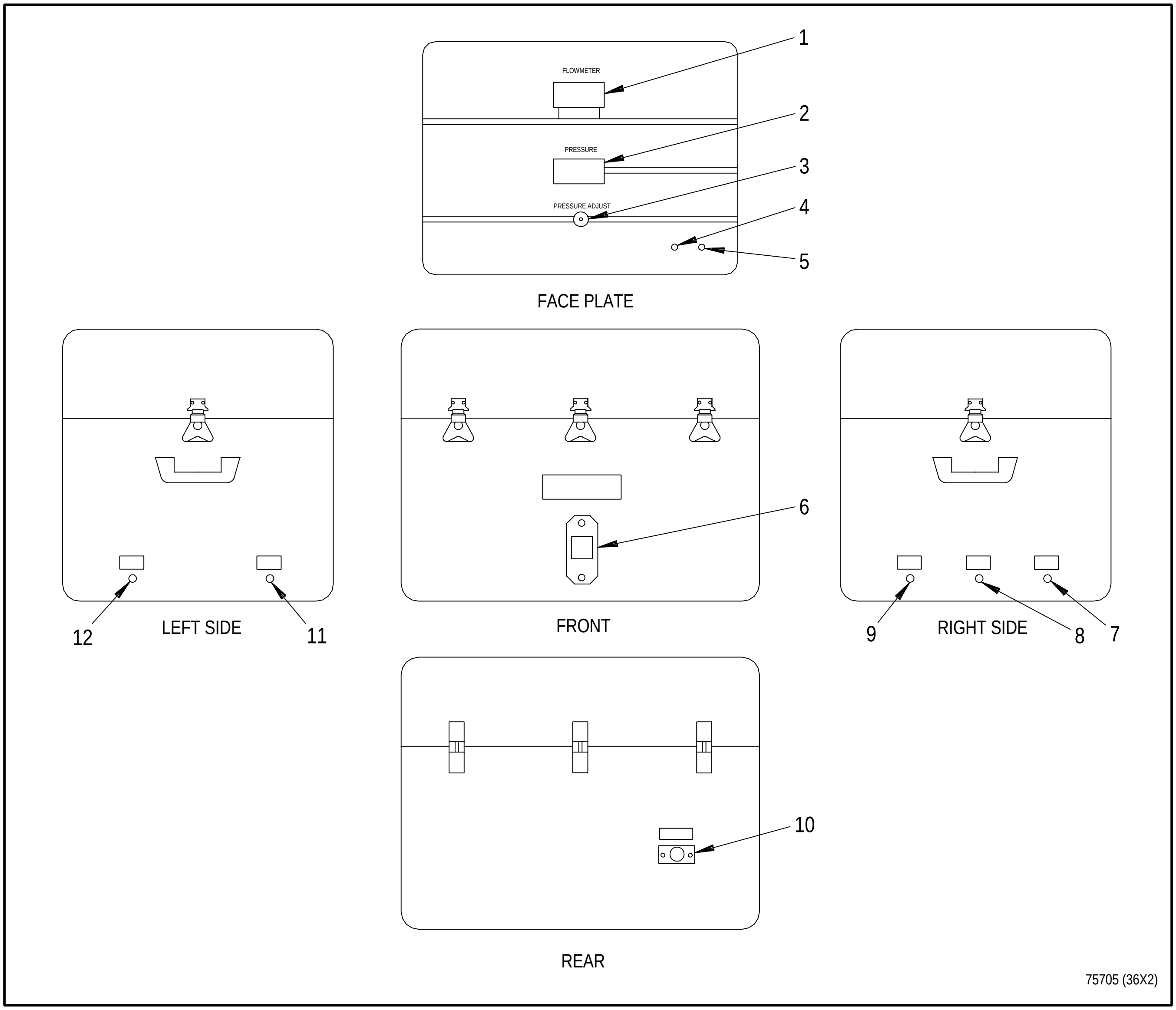
c. Shut down checker as follows:

(1) Turn pressure adjust knob(3) counterclockwise until regulating spring pressure is absent.

(2) Toggle power ON/OFF switch(5) to Off position.

(3) Remove all hoses and store in top cover of checker.

(4) Cap all ports.



1. Flowmeter display
2. Pressure display
3. Pressure adjust knob
4. Fuse
5. Power ON/OFF switch
6. Programming port
7. Flowmeter air outlet port
8. Pressure tap port
9. Shop air inlet port
10. Electrical receptacle
11. Regulated air outlet port
12. Flowmeter air inlet port

Figure 1. Habco 1093005 Portable Air Flow Checker - General Procedures

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL PROCEDURES OIL NOZZLE ASSEMBLY, AIR OR VISUAL FLOW CHECK

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0	8 Blank	0		

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for depot maintenance to ensure oil passages of all jets are clear of debris and are free flowing before assembly.

NOTE

All oil jets shall be checked by flowing air, or visual inspection before assembly.

2. AIRFLOW PROCEDURE.

a. Airflow check shall be accomplished by applying air pressure to inlet side of jet and checking airflow at jet exit. Air shall flow freely through nozzle with no indication of blockage.

b. A rubber seal shall be used between air nozzle and inlet fitting to preclude blowby, giving a false indication of air passing through jet.

c. Install or bag oil jet after passing airflow check to prevent contamination.

d. If oil jet is suspected of blockage, retain for Engineering review.

3. VISUAL PROCEDURE.

a. Examine oil jet by sighting down oil jet nozzle with a light source at oil supply inlet.

b. View oil jet nozzle at oil discharge.

c. Oil jet nozzle shall show a circular opening.

d. If oil jet is suspected of blockage, retain for Engineering review.

4. DETAIL JET FLOW CHECK REQUIREMENTS.

(See Table 1.)

a. All detail jets shall be airflow or visually checked before final assembly. Associated hardware shall also be checked. (See table 1.)

Table 1. Oil Jet Flow Checks

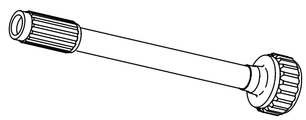
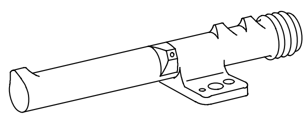
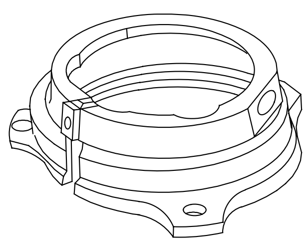
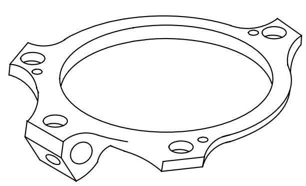
Part Numbers	Illustration and Part Name	Models	Flow Check Procedure
4071013	 PN 4071013 –C Gearbox Drive Shaft	-229	Visual
4057397	 PN 4057397 –C Gearbox Bearing Nozzle	-229	Airflow
4064002	 PN 4064002 –C Gearbox Bearing Retaining Plate	-229	Airflow
4065138	 PN 4065138 –C Gearbox Bearing Retaining Plate	-229	Airflow

Table 1. Oil Jet Flow Checks (continued)

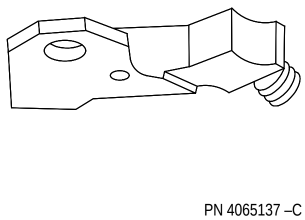
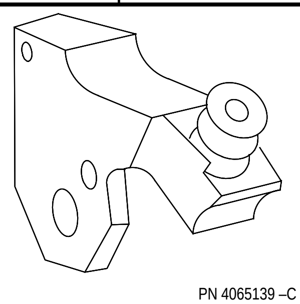
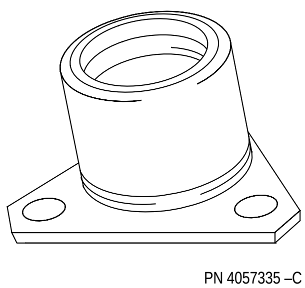
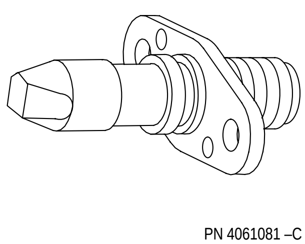
Part Numbers	Illustration and Part Name	Models	Flow Check Procedure
4065137	 Gear Pump Oil Nozzle	-229	Airflow
4065139	 Gear Pump Oil Nozzle	-229	Airflow
4057335	 Gearbox Bearing Housing	-229	Visual
4061081	 Gearbox Bearing Nozzle	-229	Airflow

Table 1. Oil Jet Flow Checks (continued)

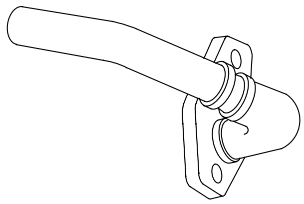
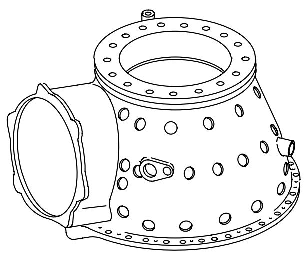
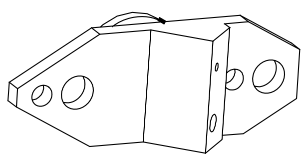
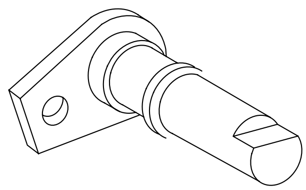
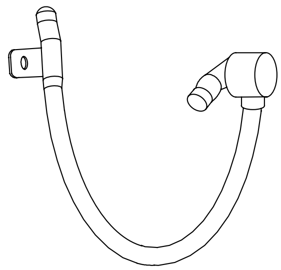
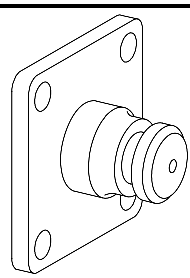
Part Numbers	Illustration and Part Name	Models	Flow Check Procedure
4064156	 PN 4064156 –C No. 1 Bearing Pressure Tube Assembly	-229	Airflow
4038606	 PN 4038606 –C No. 2 Bearing Housing Support	-229	Visual
4073689	 PN 4073689 –C No. 2 Bearing Nozzle	-229	Airflow

Table 1. Oil Jet Flow Checks (continued)

Part Numbers	Illustration and Part Name	Models	Flow Check Procedure
4039917	 PN 4039917 –C No. 3 Bearing Nozzle	-229	Airflow
4035859	 PN 4035859 –C No. 4 Bearing Pressure Manifold Assembly	-229	Airflow
4071205-01	 PN 4071205–01 –C No. 5 Bearing Adapter	-229	Airflow

WORK PACKAGE

INTRODUCTION

GENERAL CLEANING PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	11				
3	0				
4 Blank	0				

1. INTRODUCTION.

a. This work package introduces the 030 00 through 069 00 series of work packages for the general cleaning procedures (SPOP). The following work packages/ subordinate work packages are included in this series.

WP/SWP No.	Title
031 00	Cleaning, General
031 01	Cleaning, Vapor Degreasing (SPOP 3)
031 02	Cleaning, Glass Bead Blast, Dry (SPOP 17)
031 03	Cleaning, Glass Bead Blast, Wet (SPOP 16)
031 04	Cleaning, Carbon Solvent and Paint Stripper, Two Step (SPOP 7)
031 05	Cleaning, Soft Grit Blast (SPOP 8)
031 06	Cleaning, Alkaline Descaler With Acid, Three Step (SPOP 11)
031 07	Cleaning, Alkaline Descaler Without Acid, Three Step (SPOP 13)
031 08	Cleaning, Alkaline Rust Remover, Quick Soak (SPOP 18)
031 09	Cleaning, Alkaline Rust Remover, Long Soak (SPOP 203)
031 10	Cleaning, Solvent Emulsion (SPOP 205)
031 11	Cleaning, Alkaline Rust Remover and Acidic Descaler With Phosphoric Acid, Four Step (SPOP 211)
031 12	Cleaning, Alkaline Rust Remover and Acidic Descaler Without Phosphoric Acid, Four Step (SPOP 213)
031 13	Cleaning, Grit Blast, Dry (SPOP 218)
031 14	Cleaning Steel, Magnesium, or Titanium Parts; Paint, Antigallant, and Varnish Removal (SPOP 250)
031 15	Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)
031 16	Cleaning Steel or Titanium Parts, Antigallant and Varnish Removal (SPOP 252)

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 16

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 16	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Cleaning of Gas Turbine Engines and Parts	T.O. 2J-1-13

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, alkaline descaling (SPS 232)	Turco 4008 NP-2
Compound, alkaline descaling (SPS 237)	Clarco JEC-1 or Delchem 2128-A or Oakite Jet Strip Special or Turco NP-3
Compound, carbon removing	Penetone Formula 423 or Turco Super-Carb or Wyandotte P-1075
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46
Glass beads, 270 mesh	MIL-G-9954, Size 13
Grit, aluminum oxide, SAE grain Size 240	Carborundum Blastite BT No. 240 or Exolon Fast Blast No. 240 or Norton Arrow Blast No. 240
Grit, Aluminum oxide, SAE grain Size 320	Exolon Polishing Grain RHT or Norton Alundum 320 E1B
Grit, soft	Nielco Shell Clean No. 12/20 or Temper-Tex HW-20 or Turco Carboblast

CONSUMABLE MATERIALS (continued)

Nomenclature		Specification/Vendor Part Number
Solutions (Refer to T.O. 2-1-111 for solution preparation and maintenance.)		
PS 227	Alkaline permanganate solution: Potassium permanganate (PMC 1304)	O-P-566
	Sodium hydroxide (PMC 1601)	O-S-598
PS 233	Alkaline permangante compound	Ardrox 188 or Cee-Bee J88 or Turco 4338 or Wyandotte 1113 O-P-566
	(PMC 1267) Potassium permanganate (PMC 1304) (Used in maintaining solution only)	
PS 240	Alkaline rust remover solution: Alkaline rust remover	
	(PMC 1269)	Wyandotte Ferlon
	Wetting agent (PMC 1689) (Received with PMC 1269)	
PS 241	Acidic scale conditioning compound: Acidic scale conditioner	
	(PMC 1270)	Wyandotte No. 1112

CONSUMABLE MATERIALS (continued)

Nomenclature		Specification/Vendor Part Number
SPS 2	Alkaline rust remover solution: Alkaline rust remover (SPMC 2)	Cee-Bee J84A
SPS 5	Alkaline rust remover solution: Alkaline rust remover (SPMC 5)	Kelite 235
SPS 7	Alkaline rust remover solution: Alkaline rust remover (SPMC 7)	Turco 4181 or Turco 4781-7
SPS 9	Acidic scale conditioning compound: Acidic scale conditioner (SPMC 9)	Cee-Bee J-19
SPS 10	Acidic scale conditioning compound: Acidic scale conditioner (SPMC 10)	Turco No. 4931
SPS 12	Alkaline rust remover solution: Alkaline rust remover (SPMC 12)	Magnus Aero-Dip
SPS 13	Alkaline permanganate compound: Alkaline permanganate (SPMC 13)	DuBois SR 5000 or Magnus 2400

CONSUMABLE MATERIALS (continued)

Nomenclature		Specification/Vendor Part Number
SPS 14	Acidic scale conditioning compound: Acidic scale conditioner (SPMC 14)	Magnus No. 8500
SPS 21	Phosphoric acid solution, inhibited: Phosphoric acid, inhibited (SPMC 21)	Magnus 853 or Turco 4409 or Wyandotte Phos-It
SPS 22	Alkaline rust remover solution: Alkaline rust remover (SPMC 22)	Wyandotte Alkaway
SPS 25	Alkaline rust remover solution: Alkaline rust remover (SPMC 25)	DuBois DuStrypp
SPS 52	Alkaline rust remover solution: Alkaline rust remover (SPMC 52)	Ardrox 185
SPS 53	Acidic scale conditioning compound: Acidic scale conditioner (SPMC 53)	Ardrox 1873

CONSUMABLE MATERIALS (continued)

Nomenclature		Specification/Vendor Part Number
SPS 86	Braze descaling solution: Sodium lauryl sulfate (SPMC 87) Sulfamic acid (PMC 1550) Thiourea (SPMC 86)	-
SPS 235	Glass bead slurry:	
	Glass beads (PMC 3084)	MIL-G-9954, Size 13
SPS 908	Carbon removal solution:	
	Blue Gold (PMC 1284)	Alkali Cleaner (Blue Gold Concentrate)
Solvent, degreasing		O-T-236 or MIL-T-81533
Solvent, petroleum		P-D-680, Type II

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance cleaning of engine parts.

2. PURPOSE OF CLEANING.

a. Depot cleaning of engine parts has the following basic objectives:

(1) Remove soil and deposits which could reduce efficiency of operation.

(2) Remove deteriorated coatings or coatings for which stripping is required in order to inspect parts.

(3) Prepare surfaces for repair processes such as plating, welding, brazing, and application of compounds or coatings.

(4) Prepare parts adequately for inspection.

3. IMPACT.

a. Following instructions represent manufacturer’s recommendation. Air Force personnel, refer to T.O. 2J-1-13. See T.O. 2-1-111 for Special Process Operating Procedures (SPOP).

4. GENERAL CLEANING CAUTIONS.

a. Situations prompting these cautions frequently occur whenever cleaning is done. They shall be obeyed unless specifically countermanded in order to ensure that parts are not damaged.

(1) Care shall be given to protection of part numbers, service markings, or critical surfaces where cleaning processes might obliterate or cause damage. These shall be masked or other precautions taken.

(2) Hollow shafts inaccessible to wire brushing that are still soiled after cleaning may be glass bead cleaned; however, thorough inspection shall be accomplished to ensure removal, of all glass and residue. Critical surfaces such as journals, gearteeth and splines, require masking prior to glass bead cleaning.

(3) Do not use SPOP 16 on turbine blades as abrasive residue tends to fill in cracks.

(4) Do not use SPOP 203 on aluminum parts, or assemblies with aluminum components.

(5) Do not use SPOP 218 on aluminum or magnesium parts or assemblies with aluminum or magnesium components.

NOTE

Chemical severity rating in order of increasing strength; SPOP 3, 7, 18, 203, 13, 213, 11, 211, and 709. Blasting severity rating in order of increasing strength: SPOP 8, 9, 16, 218, and 17.

(6) Nickel-cadmium plating shall not be exposed to any SPOP stronger than SPOP 18. All other platings may be exposed to SPOP 203 with exception of nickel on stainless steel (SPOP 26) which may be treated with SPOP 11, 13, 211 and 213 and silver on stainless steel (SPOP 24) which may be treated with SPOP 13 and 213.

(7) Certain engine parts, either during manufacture or repair procedure, are coated with various types of metal spray. When repaired areas are encountered, it shall be determined whether any form of metal spray was used. Refer to T.O. 2-1-111 for acceptable cleaning processes for plasma sprayed or flameplated parts.

(8) If abrasive methods are used to clean flame-sprayed parts, do not erode surface coat.

(9) In order to avoid possibility of damage due to hydraulic action of residual oil, grease, cleaning fluids, or other liquids, make sure all blind holes into which studs, bolts, inserts, screws, bushings, etc., will be driven are thoroughly cleaned and drained of all fluid or grit.

(10) Titanium weldments and assemblies shall not be processed through vapor degreasers in order to avoid possibility of stress corrosion associated with entrapment of chlorine-containing materials in tight fitting areas. This restriction also applies to parts such as titanium disks or hubs containing inserts, sleeves, or pins.

5. OIL-WETTED PARTS - CLEANING.

a. Ensure particles are removed from areas such as corners, blind holes, and internal passages.

NOTE

- This procedure is required immediately prior to part installation, for repaired parts after repair, or for parts withdrawn from stock.
- This procedure does not apply to antifriction bearings.

b. Parts which have oil-wetted surfaces or parts which connect with any oil-wetted area through breather system, shall be thoroughly flushed using P-D-680, Type II petroleum solvent, after operations such as machining, grinding, blasting, peening or plasma spray.

c. Alternate methods such as steam cleaning or clean air blast may be used where appropriate, if it can be demonstrated that alternate procedure used removes all abrasive particles.

6. CLEANING PROCESSES.
(See Table 1.)

a. Cleaning processes are listed in table 1 in order of severity.

b. Corresponding SPOP number and work packages are listed.

Table 1. List of Cleaning Processes

Title	SPOP	WP/SWP
Vapor degreaser	3	031 01
2-step carbon solvent and paint stripper	7	031 04
Soft grit blast	8	031 05
Quick soak, alkaline rust remover	18	031 08
Long soak, alkaline rust remover	203	031 09
3-step alkaline descaler without acid	13	031 07
4-step without phosphoric acid	213	031 12
Wet abrasive blast	9	031 19
Glass bead blast, wet	16	031 03
3-step alkaline descaler with acid	11	031 06
4-step with phosphoric acid	211	031 11
Carbon removal solution	709	031 21
Dry grit blast, 320 aluminum oxide	218	031 13
Glass bead blast, dry	17	031 02

7. DEGREE OF CLEANING.

a. Certain coatings are not subjected to strong cleaners even though safe to use, due to having porous surfaces which could absorb and retain corrosive chemicals in spite of rinsing.

b. Certain parts are not subjected to acid cleaners, where acid could become trapped in crevices or cavities, and not be rinsed out thoroughly.

c. Parts normally do not lose a significant amount of material (loss of weight or change in dimensions) when cleaned by an acceptable procedure. Unless otherwise specified, cleaning procedures may be repeated once if necessary. If parts are then not adequately cleaned, alternate authorized procedures shall be considered.

d. Parts which require penetrant inspection shall be given maximum degree of cleanness.

e. Parts not requiring penetrant inspection do not require scrubbing to remove slight stains and oxide films, particularly cadmium or nickel-cadmium plated surfaces. Needless cleaning should be avoided. Only the type and degree of cleaning for proper inspection is required.

f. Paints, varnishes or enamels on aluminum covers and accessory cases do not require stripping unless subsequent penetrant inspection indicates that the paint, varnish or enamel causes fluorescence which interferes with proper crack detection.

8. CLEANING SPECIFIC TYPES OF SURFACES. (See Table 2.)

a. If parts to be welded have been cleaned by SPOP 218, dry grit blast with aluminum oxide, this shall be followed by SPOP 8, soft grit blast, SPOP 9, wet abrasive blast, or SPOP 16, wet glass bead blast. This is necessary in order to remove all traces of aluminum oxide, which would contaminate the weld area and cause a poor welded bond.

b. Various painted, aluminized, flame sprayed, plasma sprayed and proprietary coatings on parts cannot withstand certain cleaning processes. If coatings are to be cleaned and not stripped, select an acceptable cleaning method from the list in table 2.

c. Prepacked bearings shall be removed or protected when cleaning an assembly containing such bearings.

d. Nickel-cadmium plated surfaces shall not be cleaned using abrasive material, or excessively scrubbed.

e. Parts originally listed as safe to clean using SPOP 11, 211, 13 and 213 may sometimes require a repair procedure including chromium plate or buildup. Parts can then no longer be cleaned by the referenced processes. Use only SPOP 3, 7 and 203 for all subsequenet cleaning of parts having chromium plate.

Table 2. Acceptable Chemical Cleaning Processes for Coated Parts

Coating Specification and Description			Acceptable Cleaning SPOP
GROUP I* PWA 45	Aluminide	Pack process	
PWA 49	Chromium carbide	Union Carbide Flame Plate	
PWA 50	Chromium carbide	Union Carbide Flame Plate	
PWA 54	Chromium carbide Flame Plate	Union Carbide	
PWA 53-5 (1305) (AMS 7875)	Chromium carbide	Plasma Coating	203, 13, 213, 11 and 211
PWA 53-7 (1307)	Chromium carbide	Plasma coating	
PWA 53-15 (1315)	Nickel and chromium	Plasma coating	
PWA 53-17 (1317)	Nickel and chromium	Plasma coating	
PWA 53-21 (1321)	Nickel and chromium	Plasma coating	
PWA 53-37 (1337)	Nickel and aluminum	Plasma coating	
PWA 53-47 (1347)	Nickel, chromium, and aluminum	Plasma coating	
GROUP II*			
PWA 53-14 (1314)	Cobalt alloy	Plasma coating	
PWA 53-16 (1316)	Cobalt alloy	Plasma coating	
PWA 53-18 (1318)	Cobalt alloy	Plasma coating	
PWA 68	Cobalt alloy	Vapor deposited	203, 13, 213, 11 and 211

Table 2. Acceptable Chemical Cleaning Processes for Coated Parts (continued)

Coating Specification and Description			Acceptable Cleaning SPOP
GROUP III AMS 2436	Aluminide oxide	Flame sprayed	
PWA 44	Aluminized	Diffused	
PWA 46	Tungsten carbide	Union Carbide Flame Plate	
PWA 51	Tungsten carbide	Union Carbide Flame Plate	
PWA 52	Tungsten carbide	Union Carbide Flame Plate	
PWA 53-1 (1301) (AMS 7879)	Tungsten carbide	Plasma coating	
PWA 53-2 (1302)	Tungsten carbide	Plasma coating	203
PWA 53-10 (1310)	Aluminum oxide	Plasma coating	
PWA 53-12 (1312)	Zirconium oxide	Plasma coating	
PWA 53-22 (1322)	Tungsten carbide, cobalt, nickel alloy	Plasma coating	
PWA 53-33 (1333)	Magnesium zirconate	Plasma coating	
PWA 53-41 (1341)	Nickel, aluminum, and magnesium zirconate	Plasma coating	
PWA 53-46 (1346)	Nickel, chromium, and magnesium zirconate	Plasma coating	
PWA 53-69 (1369)	Nickel and copper	Plasma coating	
PWA 72	Nickel aluminide	Flame sprayed	

Table 2. Acceptable Chemical Cleaning Processes for Coated Parts (continued)

Coating Specification and Description			Acceptable Cleaning SPOP
PWA 74-1, 74-2	Nickel and graphite over PWA 53-37	Flame sprayed	203
PWA 75-1, 75-2	Nickel and graphite	Flame sprayed	
PWA 269	Nickel, copper, and indium	Flame sprayed	
GROUP IV PWA 53-12 (1313	Molybdenum	Plasma coating	18
PWA 53-58 (1338)	Molybdenum	Plasma coating	
GROUP V PWA 53-20 (1320)	Aluminum	Plasma coating	
PWA 77	Aluminide	Diffused	3 and 7
PWA 578	Aluminum-Silicone	Enamel	
PA 595	Aluminum-rich	Inorganic coating	
*If coating has surface finish of 30AA or finer, the only acceptable cleaning process is SPOP 203.			

f. Cleaning Titanium Parts.

(1) Titanium disks and hubs shall not be wire brushed for any reason.

(2) Cleaning tanks used for titanium shall not be used for cleaning other alloys.

(3) Titanium weldments and assemblies shall NOT be vapor degreased (SPOP 3). Degreasing solvents are associated with stress corrosion due to entrapment of chemicals in tightfitting areas. This restriction also applies to parts such as titanium disks or hubs containing inserts, sleeves, or pins.

(4) The only titanium parts which can be vapor degreased are AMS 4901 or AMS 4921 material, and then ONLY if specified in work packages/ subordinate work packages.

9. CLEANING MATERIALS.

a. Critical factors for cleaning solutions are the strength, temperature, and immersion time. Refer to T.O. 2-1-111 for solution preparation and maintenance.

b. Consumable materials for each of the processes listed in table 1 are listed at the beginning of this work package. PS and SPS solutions are listed numerically, under the entry, Solutions.

c. Due to governmental procurement practices, specific consumable materials are not always available, and a substitute material is procured. Substituted materials are allowed provided that they:

(1) Clean as well or better than the specifically called out material.

(2) Conform to current environmental regulations.

(3) Are in the same general chemical class as the specific material, i.e. an alkaline rust remover.

(4) Have no detrimental effect upon base materials or coatings.

10. OIL TUBE CLEANING PROCEDURE.

a. Immerse tube in carbon removing compound for two hours at room temperature.

b. Rinse thoroughly with P-D-680 Type II petroleum solvent at room temperature.

c. Air dry.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES -CLEANING, VAPOR DEGREASING (SPOP 3)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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2	4				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Solvent, degreasing	O-T-236 or MIL-T-81533
Solvent, petroleum	P-D-680, Type II or Type III

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by vapor degreasing.

2. VAPOR DEGREASING PROCEDURE.

CAUTION

- To avoid part damage, do not scrub compressor disks with wire brushes.
- To avoid material removal, do not scrub or abrade nonmetallic parts of assemblies or nickel-cadmium plated parts.
- Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in work packages/subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.
- To avoid coating removal, do not use any petroleum based fluids to clean parts coated with PWA 36545 antigalling compound unless parts are to be recoated. Recoating is required if parts have been exposed to these cleaning agents.

a. Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichlorethane.

b. Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

c. Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

d. (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

e. Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

f. (Optional) Spray with P-D-680, Type II or Type III petroleum solvent (not over 125°F (52°C)) and scrub as required.

g. Drain solvent; then blow dry with filtered air at 30 psig maximum pressure.

h. (Optional) Steam clean using suitable detergent that will sufficiently degrease part.

i. Water rinse.

j. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, GLASS BEAD BLAST, DRY (SPOP 17)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Glass beads, 270 mesh	MIL-G-9954, Size 13
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by dry glass bead blasting.

2. DRY GLASS BEAD BLASTING PROCEDURE.

a. (Optional) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in work packages/ subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

(6) (Optional) Steam clean using suitable detergent that will sufficiently degrease part.

(7) Water rinse.

b. Ensure that snap diameters and critical dimensions are not altered by blast cleaning.

c. Mask all part numbers, cavities, bearing journals, splines, stretch measurements, heat codes and service time markings.

d. Blast with 270 mesh dry glass beads (size 13), using lowest pressure which will adequately clean. Avoid dwelling on any specific area longer than necessary.

e. Remove all masking.

f. Blow clean with filtered air or pressure flush with water or steam; then blow dry.

g. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, GLASS BEAD BLAST, WET (SPOP 16)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by wet glass bead blasting.

2. WET GLASS BEAD BLASTING PROCEDURE.

a. (Optional) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in work packages/ subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

(6) (Optional) Steam clean using suitable detergent that will sufficiently degrease part.

(7) Water rinse.

b. Ensure that snap diameters and critical dimensions are not altered by blast cleaning.

c. Mask all part numbers, cavities, bearing journals, splines, stretch measurements, heat codes and service time markings.

d. Blast with glass bead nozzle gun using glass bead slurry (SPS 235) at room temperature. Refer to T.O. 2-1-111 for slurry preparation and maintenance.

e. Remove all masking.

f. Blow dry with filtered air or pressure flush with cold water, hot water at 150° to 200°F (66° to 93°C) or steam; then blow dry.

g. Dip in AMS 3065 or MIL-C-15074 corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, CARBON SOLVENT AND PAINT STRIPPER, TWO STEP (SPOP 7)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, carbon removing	Turco Super-Carb or Penetone Formula 423 or Wyandotte P-1075 or P-C-111D
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the two-step carbon solvent and paint stripper method.

2. CARBON REMOVER TWO-STEP PROCEDURE.

a. (Optional - Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional - Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for S5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional - Alternate C) Degreasing.

(1) Steam clean using suitable detergent that will sufficiently degrease part.

(2) Water rinse.

NOTE

Removing parts periodically during solution soak and immersion or pressure rinsing will help to remove loosened carbon or paint.

d. Immerse in carbon removing compound at room temperature for 30 to 240 minutes as required. PC-111D shall be operated at 120° to 130°F (49° to 54°C).

e. Immerse in hot water at 150° to 200°F (66° to 93°C) for 5 minutes; then pressure flush with hot water or steam rinse as required.

CAUTION

Do not scrub compressor disks with wire brushes. Do not scrub or abrade nickel-cadmium plated or nonmetallic parts of assemblies being cleaned.

f. Scrub as required with bristle brush to remove loosened carbon, paint or gasket sealant.

g. Pressure flush with hot water at 150° to 200°F (66° to 93°C) or steam rinse as required.

h. Individually pressure rinse and stack tubing in a manner that will ensure complete and immediate draining.

i. Blow dry with filtered air.

j. Dip in AMS 3065 or MIL-C-15074 corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, SOFT GRIT BLAST (SPOP 8)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Grit, soft	Turco Carboblast or Temper-Tex HW-20 or Nielco Shell Clean No. 12/20 or walnut shells or corncob media
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by soft grit blast.

2. SOFT GRIT BLASTING PROCEDURE.

a. (Optional) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in work packages/ subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

(6) (Optional) Steam clean using suitable detergent that will sufficiently degrease part.

(7) Water rinse.

b. Ensure that snap diameters and critical dimensions are not altered by blast cleaning.

c. Mask all part numbers, cavities, bearing journals, splines and surfaces which could be harmed by blasting.

d. Clean with soft grit as required, using dry blasting gun.

e. Remove all masking.

f. Blow clean with filtered air or pressure flush with water or steam; then blow dry.

g. Dip in AMS 3065 or MIL-C-15074 corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE DESCALER WITH ACID, THREE STEP (SPOP 11)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

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APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, alkaline descaling (SPS 232)	Turco 4181 NP-2
Compound, alkaline descaling (SPS 237)	Turco NP-3 or Oakite Jet Strip Special or Delchem 2128-A or Clarco JEC-1
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46
Compound, corrosion removing	MIL-C-14460
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the 3-step method using alkaline descaler and inhibited phosphoric acid.

2. THREE-STEP CLEANING PROCEDURE (WITH ACID).

a. (Optional - Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional - Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for 5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional - Alternate C) Degreasing.

(1) Steam clean using suitable degergent that will sufficiently degrease part.

(2) Water rinse.

d. (Optional - Alternate D) Degreasing.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

e. Immerse parts in full strength alkaline descaling compound (SPS 232) at 160° to 180°F (71° to 82°C) or (SPS 237) at 245°F (118°C) for 15 to 30 minutes.

f. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for five minutes.

g. Immerse in alkaline permanganate solution (PS 227, 233 or SPS 13) at 180° to 200°F (82° to 93°C) for 15 to 30 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

h. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

i. Immerse in inhibited phosphoric acid solution (SPS 21) at room temperature for 15 to 30 minutes maximum. Refer to T.O. 2-1-111 for solution preparation.

j. (Optional) Option to Acidic Solution.

(1) Immerse parts in full strength alkaline descaling compound (SPS 232) at 160° to 180°F (71° to 82°C) or SPS 237 at 245°F (118°C) for 15 to 30 minutes.

(2) Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

k. Immerse in cold water for 5 minutes.

l. Pressure rinse with cold water or steam rinse.

m. Rinse with hot water at 150° to 200°F (66° to 93°C).

n. Blow dry with filtered air.

o. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE DESCALER WITHOUT ACID, THREE STEP (SPOP 13)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

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APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, alkaline descaling (SPS 232)	Turco 4181
Compound, alkaline descaling	Turco NP-3 or Oakite Jet Strip Special or Delchem 2128-A or Clarco JEC-1
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, corrosion removing	MIL-C-14460
Compound, hot tank cleaner	Cee-Bee C-46
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the 3-step method using alkaline descaler, but without inhibited phosphoric acid.

2. THREE STEP CLEANING PROCEDURE (WITHOUT ACID).

a. (Optional - Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional - Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for 5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional to Alternate C) Degreasing.

(1) Steam clean using suitable detergent that will sufficiently degrease part.

(2) Water rinse.

d. (Optional - Alternate D) Degreasing.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

e. Immerse parts in full strength alkaline descaling compound (SPS 232) at 160° to 180°F (71° to 82°C) or (SPS 237) at 245°F (118°C) for 15 to 30 minutes.

f. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

g. Immerse in alkaline permanganate solution (PS 227, 233 or SPS 13) at 180° to 200°F (82° to 93°C) for 15 to 30 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

h. Pressure rinse over alkaline permanganate tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

i. Immerse parts in alkaline descaling compound (SPS 232) at 160° to 180°F (71° to 82°C) or (SPS 237) at 245°F (118°C) or alkaline rust remover solution (PS 240, SPS 2, 5, 7, 12 or 22) at 190° to 210°F (88° to 99°C) for 5 to 10 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

j. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

k. Pressure rinse with cold water or steam rinse.

l. Rinse with hot water at 150° to 200°F (66° to 93°C).

m. Blow dry with filtered air.

n. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE RUST REMOVER, QUICK SOAK (SPOP 18)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

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APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, cleaning	MIL-C-14460
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the alkaline rust remover quick soak method.

2. QUICK SOAK ALKALINE RUST REMOVER PROCEDURE.

a. (Optional - Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921; then only if specified in work packages or subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

(6) (Optional) Steam clean using a suitable detergent that will sufficiently degrease part.

(7) Water rinse.

b. (Optional - Alternate B) Degreasing.

WARNING

When adding alkaline rust remover or potassium hydroxide to water, it shall be done slowly to avoid rapid reaction which causes heat generation.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon of water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

c. Immerse parts 1 to 4 minutes maximum at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 5, 7, 12, 25, 27, 52, or MIL-C-14460 corrosion remover). Immerse parts only long enough to remove rust. Refer to T.O. 2-1-111 for solution preparation and maintenance.

d. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

e. Pressure rinse with cold water or steam rinse.

CAUTION

When cleaning titanium parts, do not exceed chloride content of 10 ppm in final rinse water to reduce chloride contamination.

f. Rinse with hot water at 150° to 200°F (66° to 93°C).

g. Blow dry with filtered air.

h. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE RUST REMOVER, LONG SOAK (SPOP 203)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, cleaning	MIL-C-14460
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the alkaline rust remover long soak method.

2. LONG SOAK ALKALINE RUST REMOVER PROCEDURE.

a. (Optional - Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrsion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional - Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for 5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional to Alternate C) Degreasing.

(1) Steam clean using suitable detergent that will sufficiently degrease part.

(2) Water rinse.

d. (Optional - Alternate D) Degreasing.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

e. Immerse parts 30 to 90 minutes at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 5, 7, 12, 22, 25, 27, 52, or MIL-C-14460). Refer to T.O. 2-1-111 for solution preparation and maintenance.

f. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

g. Pressure rinse with cold water or steam rinse.

h. Rinse with hot water at 150° to 200°F (66° to 93°C).

i. Individually pressure rinse and stack tubing in a manner that will ensure complete and immediate draining.

j. Blow dry with filtered air.

k. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, SOLVENT EMULSION (SPOP 205)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, corrosion removing	MIL-C-14460

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by emulsion cleaner method.

2. EMULSION CLEANING PROCEDURE.

a. Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

b. (Optional) Prepare a solution of MIL-C-14460 at a concentration of 4 to 8 ounces per gallon water. Use at 160° to 180°F (71° to 82°C).

c. Immerse parts in cleaner at 60° to 140°F (16° to 60°C) for 30 minutes.

d. Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

e. Blow dry with filtered air at 30 psig maximum pressure.

f. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE RUST REMOVER AND ACIDIC DESCALER WITH PHOSPHORIC ACID, FOUR STEP (SPOP 211)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, cleaning	P-C-444, Type I
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46 or MIL-C-14460
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the 4-step method using alkaline rust remover, acidic descaler and inhibited phosphoric acid.

2. FOUR STEP CLEANING PROCEDURE (WITH ACID).

a. (Optional to Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional to Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for 5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional to Alternate C) Degreasing.

(1) Steam clean using suitable detergent that will sufficiently degrease part.

(2) Water rinse.

d. (Optional to Alternate D) Degreasing.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

e. Immerse parts 15 to 30 minutes at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 7, 12, 22, 25, 27, 52, or MIL-C-14460). Refer to T.O. 2-1-111 for solution preparation and maintenance.

f. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

g. Immerse parts 20 to 30 minutes at 120° to 130°F (49° to 54°C) in acidic scale conditioning compound (PS 241, SPS 9, 10, 14, 53, or Turco Scale-go). Refer to T.O. 2-1-111 for solution preparation and maintenance.

h. Pressure rinse over acidic tank with minimal amount of cold water; then immerse parts in cold water for 5 minutes.

i. Immerse parts 15 to 30 minutes at 180° to 200°F (82° to 93°C) in alkaline permanganate solution (PS 227, 233 or SPS 13). Refer to T.O. 2-1-111 for solution preparation and maintenance.

j. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

k. (Optional to Alkaline Dip) Immerse parts 15 to 20 minutes at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 7, 12, 22, 25, 27, 52, or MIL-C-14460). Refer to T.O. 2-1-111 for solution preparation and maintenance.

l. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

m. Immerse in inhibited phosphoric acid solution (SPS 21) at room temperature for 15 to 30 minutes maximum. Refer to T.O. 2-1-111 for solution preparation.

n. Immerse in cold water for 5 minutes.

o. Pressure rinse with cold water or steam rinse.

p. Rinse with hot water at 150° to 200°F (66° to 93°C).

q. Blow dry with filtered air.

r. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, ALKALINE RUST REMOVER AND ACIDIC DESCALER WITHOUT PHOSPHORIC ACID, FOUR STEP (SPOP 213)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

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REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, emulsion	Turco 3878 or Van Straaten 3201
Compound, cleaning	P-C-444, Type I
Compound, conditioning	Turco Scale-go
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Compound, hot tank cleaner	Cee-Bee C-46 or MIL-C-14460
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cleaning by the 4-step method using alkaline rust remover and acidic descaler, but without inhibited phosphoric acid.

2. FOUR STEP CLEANING PROCEDURE (WITHOUT ACID).

a. (Optional to Alternate A) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified per WP/SWP. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

b. (Optional to Alternate B) Degreasing.

(1) Prepare solution of Turco 3878, Van Straaten 3201 or P-C-444, Type I cleaning compound at a concentration of 20% in water and maintain at 20 to 25%.

(2) Immerse parts in emulsion cleaner at 60° to 140°F (16° to 60°C) for 5 to 15 minutes.

(3) Pressure rinse in hot water at 150° to 200°F (66° to 93°C).

c. (Optional to Alternate C) Degreasing.

(1) Steam clean using suitable detergent that will sufficiently degrease part.

(2) Water rinse.

d. (Optional to Alternate D) Degreasing.

(1) Prepare and maintain solution of Cee-Bee C-46 alkaline cleaning compound or MIL-C-14460 corrosion removing compound at a concentration of 4 to 8 ounces per gallon water.

(2) Immerse parts 5 to 15 minutes maximum in alkaline precleaner at 180° to 200°F (82° to 93°C).

(3) Pressure rinse with hot water at 150° to 200°F (66° to 93°C).

e. Immerse parts 15 to 30 minutes at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 5, 7, 12, 22, 25, 27, 52, or MIL-C-14460). Refer to T.O. 2-1-111 for solution preparation and maintenance.

f. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

g. Immerse parts 20 to 30 minutes at 120° to 130°F (49° to 54°C), in acidic scale conditioning compound (PS 241, SPS 9, 10, 14, 53, or Turco Scale-go). Refer to T.O. 2-1-111 for solution preparation and maintenance.

h. Pressure rinse over acidic tank with minimal amount of cold water; then immerse parts in cold water for 5 minutes.

i. Immerse parts 15 to 30 minutes at 180° to 200°F (82° to 93°C) in alkaline permanganate solution (PS 227, 233, or SPS 13). Refer to T.O. 2-1-111 for solution preparation and maintenance.

j. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

k. Immerse parts 5 to 10 minutes at 190° to 210°F (88° to 99°C) in alkaline rust remover (PS 240, SPS 2, 5, 7, 12, 22, 25, 27, 52, or MIL-C-14460). Refer to T.O. 2-1-111 for solution preparation and maintenance.

l. Pressure rinse over alkaline tank with minimal amount of cold water; then immerse parts in cold or hot water for 5 minutes.

m. Pressure rinse with cold water or steam rinse.

n. Rinse with hot water at 150° to 200°F (66° to 93°C).

o. Blow dry with filtered air.

p. Dip in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, GRIT BLAST, DRY (SPOP 218)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Grit, aluminum oxide, SAE grain size 220 or 240	Norton Alundum 320 E1B or Exolon Polishing Grain RHT
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance cleaning by dry grit blasting.

2. DRY GRIT BLASTING PROCEDURE.

a. (Optional) Degreasing.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921; then only if specified in work packages/ subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

(1) Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

(2) Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane 162° to 170°F (72° to 77°C).

(3) Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

(4) (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

(5) Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

(6) (Optional) Steam clean using a suitable detergent that will sufficiently degrease part.

(7) Water rinse.

b. Ensure that snap diameters and critical dimensions are not altered by blast cleaning.

c. Maximum allowable air pressure is 30 to 55 psig. Do not dwell in one location more than 5 seconds. Do not dwell directly on Linde Flame Plate, but overspray is acceptable. Linde Flame Plate is normally darker than the parent metal.

d. Mask all part numbers, cavities, bearing journals, splines, stretch measurements, heat codes and service time markings.

e. Blast with dry blasting gun using No. 220 or 240 aluminum oxide grit.

f. Remove all masking.

g. Blow clean with filtered air or pressure flush with cold water, hot water at 150° to 200°F (66° to 93°C) or steam; then blow dry.

h. Apply a thin film of AMS 3065 or MIL-C-15074 corrosion preventive compound, if required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING STEEL, MAGNESIUM, OR TITANIUM PARTS; PAINT, ANTIGALLANT, AND VARNISH REMOVAL (SPOP 250)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning, Soft Grit Blast (SPOP 8)	SWP 031 05

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065
Compound, corrosion preventive, petrolatum, hot application	MIL-C-11796, Class 3
Grit, soft	Turco Carboblast or Temper-Tex HW-20 or Nielco Shell Clean No. 12/20
Oil, slushing, corrosion preventive	Ferrocote 362K-2 or Pakoil No. 4042 or X59-58
Stripper	Turco 6252

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance stripping of paint, antigallant, and varnish from steel, magnesium, or titanium parts.

2. STRIPPING PROCEDURE.

a. Immerse parts in A-R stripping solution (PS 131) at 190° to 210° (88° to 99°C) until all surface coating has been removed or mostly degraded. Refer to T.O. 2-1-111 for solution preparation and maintenance.

b. (Optional to step a.) Immerse parts in Turco 6252 at 230° to 250°F (110° to 121°C) until all surface coating has been removed or mostly degraded.

c. Rinse thoroughly in clean cool water to remove alkaline stripping solution.

d. Power wash, if necessary.

e. Scrub parts with a fiber brush to remove last traces of surface coating.

NOTE

The following step shall not be performed for antigallant removal.

f. (Optional) Dry soft grit blast per SWP 031 05 to remove last traces of surface coating.

g. Rinse thoroughly in clean cool water.

h. Dry with air blast.

i. For removal of SermeTel W only, lightly blast with wet glass beads per SWP 031 03 to remove last traces of coating.

NOTE

The following step shall not be performed on titanium parts.

j. For temporary processing and corrosion prevention of steel or magnesium parts, corrosion preventive compound AMS 3065, slushing oil, or hot applied petrolatum compound may be used.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING ALUMINUM PARTS, PAINT AND VARNISH REMOVAL (SPOP 251)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Soft Grit Blast (SPOP 8)	SWP 031 05

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Stripper	Turco 6252
Grit, soft	Turco Carboblast or Temper-Tex HW-20 or Nielco Shell Clean No. 12/20

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance stripping of paint or varnish from aluminum parts.

2. STRIPPING PROCEDURE.

a. Immerse parts in Race B/Race A stripping solution (PS 132) at room temperature until all surface coating has been removed or mostly degraded. Do not leave part in stripping solution overnight. Refer to T.O. 2-1-111 for solution preparation and maintenance.

b. (Optional to step a.) Immerse parts in Turco 6252 at 230° to 250°F (110° to 121°C) until all surface coating has been removed or mostly degraded.

c. Scrub parts with a fiber brush to remove last traces of surface coating.

d. (Optional) Dry soft grit blast per SWP 031 05 to remove last traces of surface coating.

e. Rinse thoroughly in clean cool water to remove acid stripping solution.

f. Rinse thoroughly in hot water at 160° to 200°F (71° to 93°C).

g. Dry with air blast.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING STEEL OR TITANIUM PARTS, ANTIGALLANT AND VARNISH REMOVAL (SPOP 252)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Soft Grit Blast (SPOP 8)	SWP 031 05

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Tetrachloreoethylene (perchlorethylene)	O-T-236
Trichloroethane	MIL-T-81533
Grit, soft	Turco Carboblast or Temper-Tex HW-20 or Nielco Shell Clean No. 12/20

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance stripping of antigallants or varnish.

2. (OPTIONAL) DEGREASING.

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in work packages/ subordinate work packages. Degreasing fluid can cause stress corrosion in titanium parts.

a. Degreasing fluid shall be either O-T-236 tetrachloroethylene (perchlorethylene) or MIL-T-81533 trichloroethane.

b. Operating temperature for tetrachloroethylene is 248° to 256°F (120° to 125°C) and for trichloroethane is 162° to 170°F (72° to 77°C).

c. Lower part not faster than 2.2 inches per second into vapor region; then suspend until condensation stops.

d. (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.

e. Raise part out of vapor not faster than 2.2 inches per second; then drain only until dry.

f. (Optional) Steam clean using a suitable detergent that will sufficiently degrease the part.

g. Water rinse.

3. STRIPPING PROCEDURE.

a. Immerse parts in alkali stripping solution (PS 110 or PS 240) at 170° to 190°F (77° to 88°C) for approximately 30 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

b. Rinse in clean water to remove alkali stripping solution.

c. Immerse parts in chromic acid solution (SPS 38) at 170° to 180°F (77° to 82°C) for 30 to 40 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

d. (Optional) Dry soft grit blast per SWP 031 05 until last traces of antigallant or varnish are removed.

e. Rinse thoroughly in clean water to remove all traces of acid.

f. Remove any remaining residues with a pressure water blast.

g. Dry with air blast.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, PWA 60 GRAPHITE VARNISH OR PWA 474 ANTIGALLING COMPOUND REMOVAL FROM TITANIUM COMPRESSOR BLADE ROOTS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures ----------------	T.O. 2-1-111
Introduction and General Information -------------	T.O. 2J-F100-53-1
Cleaning, Alkaline Rust Remover, Quick Soak (SPOP 18) ------------------------	SWP 031 08
Cleaning, Soft Grit Blast (SPOP 8) --------------	SWP 031 05

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Stripping bath	Cee-Bee A-227D
Grit, soft	Turco Carboblast or Temper-Tex HW-20 or Nielco Shell Clean No. 12/20

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance stripping of PWA 60 graphite varnish or PWA 474 antigalling compound from titanium compressor blade roots.

2. STRIPPING PROCEDURE.

a. Clean parts per T.O. 2J-F100-53-1, SWP 031 08 or immerse in PS 101 or PS 240 alkaline cleaner at 180° to 200°F (82° to 93°C) for 10 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

b. Rinse thoroughly in clean water.

c. Rinse in hot water. Dry thoroughly, using air blast if necessary.

CAUTION

Stripping bath is a two-layered liquid. Upper layer is an oil seal to reduce vapors. Lower layer is the stripping solution, which must not become contaminated with water.

d. Ensure that parts to be stripped are completely dry before immersing. Immerse parts completely in lower layer of Cee-Bee A-227D stripping bath at room temperature for 15 minutes.

CAUTION

Ensure that no droplets of rinse water splash into stripping bath. Water contamination could cause the stripping solution to become corrosive toward parts.

e. Remove parts from stripping bath and spray rinse with clean water. Scrub with a nylon or tampico brush as required to remove varnish or antigalling compound residues.

f. (Optional) Dry soft grit blast per SWP 031 05 to remove antigallant or varnish.

g. Inspect parts. If varnish/ antigallant removal is not complete, repeat steps c., d. and e. as necessary. Do not exceed 60 minutes total immersion time.

h. Final rinse in hot water and air dry.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, RTV SILICONE RUBBER REMOVAL (SPOP 254)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Introduction and General Information	- - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Anodize Touch-up, Brush or Swab (42)	- - - - - - - - - - - - - -	SWP 092 16

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Remover, RTV silicone rubber compound	Cee-Bee C105HF or Cee-Bee C105NC or Turco 6045
Solvent, petroleum	P-D-680, Type II

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of RTV silicone rubber compounds from parts.

2. STRIPPING ALL PARTS EXCEPT ANODIZED ALUMINUM.

CAUTION

Do not contaminate stripping solution with water. Do not use in plastic containers. To prevent evaporation of stripping solution, keep tank covered when not in use.

NOTE

As an option, water jet blast may be used to remove RTV silicone rubber. Use minimum amount of pressure required to remove RTV silicone rubber.

a. Immerse parts to be stripped in RTV silicone rubber compound remover at room temperature for two hours.

b. Inspect parts for silicone rubber residues. If necessary, scrub parts with soft fiber brush to remove as much degraded silicone rubber compound as possible.

c. Repeat steps a. and b. until silicone rubber is completely removed.

d. Spray or rinse parts with petroleum solvent P-D-680, Type II to remove last traces of residue.

3. STRIPPING ANODIZED ALUMINUM PARTS ONLY.

CAUTION

- Immerse anodized aluminum parts completely in solution. Partial exposure may result in corrosive attack at the liquid/atmosphere boundary.
- Do not contaminate stripping solution with water. Do not use in plastic containers. To prevent evaporation of stripping solution, keep tank covered when not in use.

NOTE

As an option, water jet blast may be used to remove RTV silicone rubber. Use minimum amount of pressure required to remove RTV silicone rubber.

a. Immerse parts to be stripped in RTV silicone rubber compound remover at room temperature for 1 hour.

b. Inspect parts for silicone rubber residues. If necessary, scrub parts with soft fiber brush to remove as much degraded silicone rubber compound as possible.

CAUTION

Anodized aluminum parts may have their anodic coatings damaged by immersing in Cee-Bee C105HF or Cee-Bee C105NC for over 4 hours or in Turco 6045 for over 2 hours.

c. Repeat steps a. and b. until silicone rubber is completely removed.

d. Spray or rinse parts with P-D-680, Type II petroleum solvent to remove last traces of residue.

e. If necessary, touch up any surfaces bared of anodic coating using T.O. 2J-F100-53-1, SWP 092 16.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES - CLEANING, WET ABRASIVE BLAST (SPOP 9)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T. O. 2-1-111
Introduction and General Information	T. O. 2J-F100-53-1
Cleaning, Vapor Degreaser	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, wet abrasive	SPS 230
Oil, corrosion preventive	MIL-C-15074 or AMS 3065

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for cleaning selected engine parts using a wet abrasive blast.

2. WET ABRASIVE BLAST (SPOP 9).

CAUTION

Do not vapor degrease restricted titanium parts.

NOTE

Vapor degreasing is an optional operation.

a. Vapor degrease part per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

WARNING

Novaculite grit is dangerous if dust is inhaled. Use respirator when handling dry product.

b. Ensure that snap diameters, critical dimensions, part numbers, bearing journals, splines, stretch measurements, heat codes, and service time markings are not altered or obscured by blast cleaning. Mask if necessary.

c. Blast part using wet abrasive nozzle gun and wet abrasive compound. Refer to T.O. 2-1-111.

d. Pressure rinse with cold or hot water.

e. Blow dry with air.

f. Dip part in corrosion preventive compound (MIL-C-15074 or AMS 3065).

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES -

DESCALING, FUEL MANIFOLD BRAZED JOINTS (SPOP 220)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 12	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Sodium lauryl sulfate	-
Sulfamic acid	-
Thiourea	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance descaling of fuel manifold brazed joints.

2. DESCALING PROCEDURE.

(See Tables 1 and 2.)

a. Refer to tables 1 and 2.

Table 1. SPOP 220 Descaling of Fuel Manifold Brazed Joints

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	CAUTION SPS 86 descaling solution is intended primarily for use on stainless steel manifolds having joints silver brazed per AMS 2664. Do not use this procedure for titanium or alumnium parts. NOTE Turn off heat to descaling solution when not in use, and cover tank to minimize evaporation.				
1	Remove all plugs, obstructions, and foreign material from manifold.				
	WARNING Ensure that solution temperature does not exceed 145°F (63°C). Irritating fumes may be given off at higher temperature.				
2	Immerse manifold in descaling solution in ultrasonic tank. Suspend manifold at least 3 inches above transducer(s).	30	SPS 86 * * For solution preparation and maintenance, refer to table 2.	135 to 145	57 to 63

Table 1. SPOP 220 Descaling of Fuel Manifold Brazed Joints (continued)

NOTE

If pump is not available, Operation 3 may be omitted, provided all air is excluded from internal cavities by other means.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Flow descaling solution through the immersed manifold, using a circulating pump at low pressure and slow flow rate (approximately 3 to 5 psig at 50 gallons/ hour).				

CAUTION

Do not allow parts to dry between descaling and rinsing operations.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Drain manifold thoroughly over descaling tank.	As req'd.			
5	Rinse thoroughly in clean water.	0.5 to 1.0	Water or Hot water	Room 150 to 185	Room 66 to 85
6	Hot water rinse	0.5 to 1.0	Hot water	150 to 185	66 to 85
7	Air dry all external and internal surfaces	0.5 to 1.0	Shop air (filtered)		

Table 2. Solution Preparation for Braze Descaling Solution

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
WARNING Do not exceed maximum operating temperature, or solution could produce irritating fumes.				
SPS 86 Braze descaling solution	Sulfamic Acid	15.20 oz/gal	14.40 to 16.00 oz/gal	Precaution: Keep tank covered when not in use, to minimize evaporation.
	Thiourea	10.25 oz/gal	8.75 to 11.75 oz/gal	1. Fill ultrasonic tank with 70% required amount of tap water.
	Sodium Lauryl Sulfate	0.25 oz/gal	0.20 to 0.30 oz/gal	2. Heat water at 135° to 145°F (57° to 63°C).
				3. Add required amount of sulfamic acid.
				4. Stir to dissolve.
				5. Add required amount of thiourea.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				6. Stir to dissolve.
				7. Add required amount of sodium lauryl sulfate.
				8. Stir to dissolve.
				9. Fill tank to 90% operating volume with tap water, maintaining approximately 135°F (57°C).
				10. Stir to mix.
				11. Fill remainder of operating volume of tank with tap water and maintain specified temperature.
				12. Stir to mix.
				13. Rinse thoroughly all tools and equipment used in preparation.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				Solution Maintenance: NOTE This procedure is recommended as a daily check until solution stability is established. Subsequent pH testing may then be less frequent.
			ph: 0.40 to 0.50	1. Remove sample of SPS 86 from tank and allow to cool to room temperature.
				2. Determine pH using pH meter.
				3. If pH is higher than 0.50, add sulfamic acid to tank as required, to bring pH within operating limits.
				4. If pH is lower than 0.40, add sodium hydroxide solution or pellets to tank, to raise pH within operating limits.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				Stock Loss Test: **NOTE** This procedure is recommended as a weekly check until solution stability is established. Subsequent testing may then be more or less frequent. 1. Remove approximately 200 ml sample of SPS 86 from tank. 2. Adjust pH to 0.40 to 0.50 if necessary. 3. Prepare copper test panel 1.0 x 1.0 x 1/16 inch, having a 1/8 inch hole at one corner. 4. Clean test panel in 1:1 HN03 for approximately 15 seconds, or until oxide film is removed. 5. Rinse in deionized water and dry thoroughly.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				6. Weigh test panel on analytical balance, handling with tweezers or plastic gloves. Record weight. 7. Heat descaling solution sample to 140° ±2°F (60° ±1°C) and maintain. Suspend test panel (using a copper wire hook) in solution for 60 minutes. 8. Remove test panel, water rinse, and dry thoroughly. 9. Reweigh test panel, handling with tweezers or plastic gloves. Record weight. 10. Subtract weight in step 9 from that in step 6. 11. If weight loss is less than 0.010 gram, add thiourea to tank (within operating limits), and repeat Stock Loss Test.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				12. If weight loss is greater than 0.020 gram, drain a suitable portion from tank and replace with SPS 86 solution make-up, but with thiourea omitted. Repeat Stock Loss Test as necessary. Surface Tension Test: **NOTE** This procedure is recommended as a daily check until solution stability is established. Subsequent testing may than be less frequent.This procedure is recommended as a daily check until solution stability is established. Subsequent testing may than be less frequent. 1. Construct a 3 inch diameter loop using stainless steel wire 0.016 inch or greater in thickness, with handle (stem) long enough to immerse loop in descaling solution.

Table 2. Solution Preparation for Braze Descaling Solution (continued)

Solution No. and Name	Composition			Preparation
	Material	Make-Up	Operating Limits	
SPS 86 Braze descaling solution (continued)				2. Immerse wire loop in SPS 86 tank, and withdraw slowly. 3. If soapy film is not held across wire loop, add sodium lauryl sulfate to tank (within operating limits), and repeat Surface Tension Test.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL CLEANING PROCEDURES -

CLEANING, CARBON REMOVAL SOLUTION (SPOP 709)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Alkali cleaner (PMC 1284)	Blue Gold Concentrate
Carbon removing compound PMC 9047 or PMS 9031)	P-C-111

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This Subordinate Work Package contains instructions for depot maintenance removal of carbon from fuel manifolds.

2. CARBON REMOVAL PROCEDURE.

NOTE

As an option P-C-111 (PMC 9047 or 9031) may be substituted for SPS 908.

a. Prepare suitable quantity of diluted cleaning solution for ultrasonic tank which will accommodate part. An effective proportion to use is SPS 908 (1 gallon of Blue Gold Concentrate to 7 gallons of distilled or de-ionized water).

b. Lower part into solution slowly enough so that all air bubbles are released, and all cavities completely filled with cleaning solution.

c. Allow part to hang freely, so that it does not contact tank or any other part. Locate any openings at top of assembly.

d. Position part in tank so that ultrasonic energy is directed for maximum effect.

e. Turn on transducers to help release any residual trapped air.

f. Continue ultrasonic application for 2 hours, then turn off.

g. Lift each part out of solution, allowing cleaning solution and carbon (coke) particles to drain into tank. As solution is draining, shake part, if necessary, to dislodge carbon residue.

NOTE

One cleaning cycle consists of steps 2.b. through 2.g.

h. Repeat for 15 additional cycles or more, as required to clean part so that no carbon is visibly remaining.

NOTE

Total ultrasonic time of 32 hours is a preferred maximum; however, additional exposure, with or without ultrasonic energy, will not adversely affect part integrity.

i. Remove parts from cleaning solution. Drain, rinse, and flush each part thoroughly with tap water.

j. Heat parts 140° to 180°F (60° to 82°C) to improve drying.

k. Dry internal surfaces with clean, dry, compressed air or nitrogen, maintained at less than 30 psig discharge pressure. Drying will require 2 to 4 minutes for a typical part.

WORK PACKAGE

INTRODUCTION

GENERAL INSPECTION PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 2

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	14				

1. INTRODUCTION.

a. This work package introduces the 070 00 through 089 00 series of work packages for the introduction and general information manual. The following work packages/ subordinate work packages are included in this series:

WP/SWP No.	Title
071 00	Inspection, Physical, General
071 01	Inspection, Pit Depth (SPOP 126 and 127)
071 02	Inspection, Ultrahigh Supersensitive Fluorescent Penetrant (SPOP 776)
071 03	Inspection, Fluorescent Penetrant, General
071 04	Inspection, Fluorescent Penetrant, Normal Sensitivity (SPOP 62)
071 05	Inspection, Fluorescent Penetrant, Local Application (SPOP 70)
071 06	Inspection, Fluorescent Penetrant, High Sensitivity (SPOP 82)
072 00	General Inspection Procedures - Inspection, Magnetic Particle, General
073 00	General Inspection Procedures - Inspection, Magnetic Particle (SPOP 101 through 118)
074 00	General Inspection Procedures - Hardness Inspection Method For Abradable Materials
075 00through 089 00	Open

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, PHYSICAL, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 13	0				
14 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Illustrated Parts Breakdown	T.O. 2J-F100-54

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	MIL-C-6529
Compound, corrosion preventive	MIL-C-0081309, Type I
Oil, lubricating	MIL-L-6082, Grade 1065

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for depot maintenance general physical inspection.

2. GENERAL INSPECTION.

a. Thorough and intelligent inspection of all engine parts is one of the most important factors for dependable depot repair. Strong emphasis shall be placed on careful inspection and decisions it involves.

b. The main purpose of instruction contained in this manual is to supplement judgment that a qualified inspector has gained after years of experience.

c. If inspection reveals it necessary to replace fitted spacer, tag spacer to indicate that replacement should be made with part of same thickness to facilitate assembly operations.

d. If reassembly does not immediately follow inspection, protect parts from corrosion damage by following procedure. Cover all unprotected surfaces of magnesium and steel parts or any other part with which corrosion difficulties are experienced, with light coat of one part MIL-C-6529 aircraft engine corrosion preventive compound, to three parts MIL-L-6082 Grade 1065 aircraft engine lubricating oil. MIL-C-0081309, Type I (thin film, water-displacing) may be used instead of the above.

e. During inspection, keep record of condition of all parts and record of all fits, clearances and spring pressures.

f. Tag, for replacement, any part which does not meet serviceable or reparable limits.

g. Attach tag describing necessary reconditioning required to the part. Tag shall remain attached to part until final assembly and should be marked with a Warning to check fit or clearance.

h. When making out inspection records or reports, use only words which accurately describe existing condition.

i. Depth of rust pits on curved or nonaccessible areas, may be determined by visual aids with known pit depths.

j. Needle pointed dial indicators mounted on anvils may be used to determine pit depths on flat surfaces.

k. In event of disk failure, resultant extreme unbalance of rotor may create severe stresses in adjacent parts. Some of these parts may require replacement; however, no general recommendations can cover all possibilities. It is recommended that individual cases be reported to United Technologies Corporation, Pratt & Whitney, Government Engine Business, P.O. Box 109600, West Palm Beach, Florida 33410-9600 for judgment.

l. Engine parts which have been subjected to fire extinguishing agents shall be inspected per specific instructions for individual part being inspected.

m. Life cycle limits of parts are located in T.O. 2J-F100-54, Illustrated Parts Breakdown, and referenced in the -6 Aircraft manual. Replace any parts per the replacement schedule.

3. PHYSICAL INSPECTION.

a. Physical inspection leads to the detection of defects of dimensional and/or visual nature such as wear, scuffing or denting.

b. Nondestructive inspection method leads to the detection of defects and fatigue cracks which could not be seen during normal inspection.

CAUTION

Defects, however slight, shall be evaluated and decisions made relative to repair, replacement or reuse. Parts subject to high stresses during usage shall command rigid adherence to this caution.

c. Nondestructive inspection shall include tabularization of nature and extent of defects found and final decision as to suitability of parts for further service.

d. Inspect gearteeth at roots and at pitch line of thrust side. Inspect splines at roots.

e. Inspect fillets and sharp angles on stressed parts.

f. Note galled or roughened areas carefully for beginning of fatigue life.

g. Oil holes in stressed areas shall be examined for radial cracks originating from the holes.

h. Perform magnetic particle inspection per MIL-I-6868 and penetrant inspection per MIL-I-6866, placing emphasis on inspection for defects resulting from service use.

4. DIMENSIONAL INSPECTION.

a. Measure parts carefully and accurately when dimensions are specified, to establish suitability of parts for continued use.

b. Ensure that parts, gages and masters are at same temperature before making measurements, to avoid errors due to contraction or expansion. Allow parts, gages and masters to stabilize at 68°F (20°C) at the inspection location, before calibrating gages. Gage masters shall be fabricated of same general material as parts if possible. If corresponding materials are not available, gage readings shall be corrected to compensate for differences in rate of expansion between masters used and parts being inspected.

5. POST-REPAIR INSPECTION.

a. Inspect parts following repair or modification to ensure that all work packages/subordinate work packages acceptance criteria satisfied.

b. Inspect by fluorescent penetrant or magnetic particle inspection, all parts which have been finish ground, before plating.

6. INSPECTION TABLE.

a. Inspection data are presented in a tabular format.

(1) The inspection area column defines the given areas of parts to be inspected. An illustration is provided.

(2) The condition column provides information relating to what to inspect for.

(3) The serviceable limits column defines the maximum deviation from manufacturer limits that will not reduce usability of the part and can be retained in use or operation without rework or repair.

(4) The reparable limits column defines the maximum amount of damage, wear that can be repaired without being detrimental to the part integrity. In addition, the following may appear in this column:

(a) No entry, which indicates no repair procedure has been established.

(b) Not reparable, which indicates damage of the type listed in the condition column cannot be repaired or is not economically feasible to repair.

b. The corrective action column indicates part replacement or references the paragraph in which the specific corrective procedure is described.

7. DEMAGNETIZATION.

a. Steel parts subjected to magnetizing process such as magnetic particle inspection and magnaflux inspection during overhaul shall be demagnetized.

8. DAMAGE/WEAR INSPECTION.

(See Table 1.)

a. Evaluate damage or wear of parts to determine and correct the basic cause and establish repair requirements. Typical damage or wear to engine parts may result from:

(1) Improper clearance.

(2) Lack of lubrication.

(3) Motion of parts relative to one another, which are bolted or pressed together.

(4) Overloading.

(5) Uneven load distribution.

(6) Excessive heat.

(7) Growth of minor scratches, tool marks, grinding cracks or nicks.

(8) Contaminants such as grit, chips, moisture or chemicals.

(9) Improper assembly or disassembly.

b. Inspect applicable parts for:

(1) Misalignment.

(2) Distortion.

(3) Foreign matter.

(4) Looseness, particularly of plugs.

(5) Out-of-roundness.

(6) Warpage.

(7) Sharp edges or burrs.

(8) Erosion.

(9) Corrosion, particularly of magnesium parts.

(10) Stretching and tapering.

(11) Obstructions in holes and passageways through manifolds, pipes, tubes or cases.

(12) Improper contact pattern on gearteeth or splines.

(13) Thread damage.

(14) Misalignment or improper projection length of studs, dowels or similar protruding parts.

(15) Lack of required smoothness and flatness on mounting pads, parting surfaces and seating surfaces. Apply bluing test using pencil carbon paper whenever a smear-type indication of surface texture is required.

c. Refer to table 1 for descriptions and usual causes of various types of physical conditions most commonly encountered during inspection of engine parts. This is intended as an aid in identifying conditions and in determining possible causes. (Refer to T.O. 2-1-111, Standard Maintenance Procedures, for photographs of sample physical conditions.)

Table 1. Physical Condition

Condition	Usual Causes
ABRASION	
A roughened area. Referred to as light or heavy, depending on extent of reconditioning required to restore surface.	Finely powdered foreign material between moving surfaces.
BEND (BOW)	
General distortion as distinguished from local distortion such as dents and peening.	Stress or uneven application of heat.
BLISTERING	
Raised area of surface separation. Usually on plated or painted parts; associated with flaking.	Imperfect bond, usually aggravated by heat, pressure, moisture or gas.
BREAK (FRACTURE)	
Complete separation by force into two or more pieces.	Fatigue or overload.
BULGE	
An outward bending or swelling.	Weakening due to excessive heat or pressure.
BURNING	
Heat injury shown by discoloration or by loss or flow of material.	Excessive heat due to lack of lubrication, improper clearance, or abnormal flame pattern.
BURNISHING	
Smoothing by rubbing, but without removal of material. May show discoloration at outer edges. Not detrimental when confined to area carring load and no evidence of pile-up or burning.	Normal operation of parts or chafing action.
BURR	
Sharp projection or rough edge.	Improper finishing after machining; peening or excessive wear

Table 1. Physical Condition (continued)

Condition	Usual Causes
CHIPPING	
Breaking out of small pieces of metal. Not to be confused with flaking.	Stress caused by nicks, scratches, inclusions, peening or improper handling.
CORROSION	
Breakdown of surface by chemical action.	Presence of corrosive agents.
CRACK	
Narrow separation of material without fracture into two or more pieces.	Sudden stress, overheating or growth of a nick or scratch.
DENT	
Small, smoothly rounded hollow in surface.	Striking of part, presence of chips between loaded surfaces or peening action.
DISTORTION	
Extensive deformation. See Bend, Bulge, Dent and Peening.	Foreign object impact, stress or overheating.
EROSION	
Removal of surface material by gas or liquid flow. See Guttering.	Flow of hot or corrosive gas or liquid or grit-loaded gas or liquid.
FATIGUE FAILURE	
Gradual yielding under repeated stresses, each of which is much less than the force required to cause failure. Cracks first develop from tiny dents, tool marks, inclusions or hairline cracks; then cracks spread out from or near surface, throughout part.	Repetitive stress at sharp corners, nicks, cracks, inclusions, tool marks, regions of galling or corrosion; or insufficient tightening of studs or bolts.

Table 1. Physical Condition (continued)

Condition	Usual Causes
FATIGUE FAILURE (continued)	
A commonly mistaken view is that metal has crystalized. This is not the case. A typical fatigue fracture usually shows a pattern of curved concentric lines. A center projected from their arcs (focal point) usually lies where original point or line of failure began.	
FLAKING	
Breaking away of plated or painted coatings.	Incomplete bond, excessive load or blistering.
FLOWING	
Spreading and displacing of plated or painted coatings.	Incomplete bond, excessive load or blistering.
FRETTING CORROSION	
Powdery oxide which appears as discoloration on surfaces bolted or pressed together under high pressure. Color on steel parts is reddish-brown and sometimes called cocoa or blood. Color on aluminum or magnesium is black. Slight fretting is not detrimental.	Rubbing off of fine metal particles by slight movement between parts, followed by oxidizing of these particles.
GALLING	
A transfer of metal from one surface to another. Not to be confused with gouging, scoring, scuffing or pickup.	Severe chafing or fretting action caused during engine operation by a slight relative motion of two surfaces under high contact pressure.

Table 1. Physical Condition (continued)

Condition	Usual Causes
GALVANIC (ELECTROLYTIC) CORROSION	
Breakdown of surface by minute electrical currents which are generated automatically when dissimilar metals contact each other.	Contact of parts having dissimilar metals. Aggravated by presence of moisture of salt.
GLAZING	
Development of a hard glossy varnish on bearing surfaces. Often considered beneficial.	Combination of heat, oil and pressure.
GOUGING	
Displacement of material from a surface by a cutting or tearing action.	Presence of a comparatively large foreign body between moving parts.
GROOVING	
Smooth rounded furrows, beginning usually as scoring on a rotating part, followed by a polishing of the sharp edges.	Parts out of alignment; abnormal relative motion of parts; or localized wear.
GUTTERING	
Severe, localized erosion.	Enlargement of a crack or similar condition by action of flame or hot gases.
INCLUSION	
Foreign material imbedded in metal. Dark spots or lines may be evidence of an inclusion at surface. Magnetic particle inspection will detect inclusions at or near the surface. Examination at the focal point of a fatigue fracture may reveal an inclusion.	Contaminant in casting at manufacture.

Table 1. Physical Condition (continued)

Condition	Usual Causes
NICK	
A sharp indentation.	Striking part by another metal object through improper handling of parts or tools before or during assembly; foreign object contact during engine operation.
PEENING	
Deformation of surface.	Impact of foreign object with repeated blows or by grit or fine foreign particles during engine operation.
PICKUP	
Rolling up of metal or transfer of metal from one surface to another.	Insufficient lubrication; grit between surfaces under pressure during assembly; unbroken edges of press-fitted parts; near-seizing of rotating parts during engine operation.
PILE-UP	
Displacement of surface fragments from one place to another. Distinguished from pickup by presence of depressions left by material displaced.	Localized spalling; foreign object contact.
PITTING	
Small, irregularly shaped cavities in a surface from which material has been removed by corrosion or chipping. Corrosive pitting is usually told by presence of deposits in the pits.	Mechanical pitting: Chipping caused by overloading, improper clearance or foreign particles. Corrosive pitting: Breakdown of surface caused by chemicals, oxidation or galvanic (electrolytic) action.

Table 1. Physical Condition (continued)

Condition	Usual Causes
SCORING	
Deep scratches made during engine operation by sharp edges or foreign particles; elongated gouges.	Presence of chips between loaded surfaces having relative motion.
SCRATCHES	
Narrow, shallow marks caused by movement of a sharp object or particle across a surface.	Improper handling of parts or tools before or during assembly or disassembly; presence of grit during engine operation.
SCUFFING	
Series of small, superficial scratches.	Sliding at rolling contact surfaces in presence of foreign particles; inadequate lubrication.
SPALLING	
Large, shallow pits or irregular, sharp-edged, relatively deep cavities caused by gradual chipping or peeling of surface. Not to be confused with flaking or pitting.	Surface cracks, non-metallic subsurface inclusions or fatigue of rolling contact surfaces.
STRESSES	
When used in describing the cause of part failure, stresses are classified as follows: Compression - action of two directly opposed forces which tend to squeeze a part together. Tension - action of two directly opposed forces which tend to pull apart. Shear - action between two opposed parallel forces.	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, PIT DEPTH (SPOP 126 AND 127)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Compound, Stop-off, low melting point alloy	Babbitrite
Eutectic alloy, low melting point	Asarco-L0158 or Belmont Alloy #2505 or Cerrobend or Metal Specialties Eutectic Alloy 158 or United Refining Quaternary Eutectic Alloy
Silicone rubber fluid	GE RTV 21
Silicone rubber hardener	Tenneco Nuocure 28
Solution, replicating	Ladd No. 451
Tape, replicating	Ladd No. 453

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance inspection of parts for measurement of pit depth.

2. PIT DEPTH MEASUREMENT.

(See Figure 1.)

a. Process part through normal cleaning cycle if this has not already been done. Clean pitted or scratched surfaces thoroughly using O-A-51 acetone. A bristle brush may be used to remove residues from bottoms of pits or scratches.

b. Prepare a replica (technically, an inverted replica) by replicating tape, replicating silicone rubber or eutectic alloy. The principle of replication is similar to making a cast imprint and is illustrated in figure 1. Pit sizes are exaggerated.

(1) Replicating tape (SPOP 126).

NOTE

This inspection procedure is suitable only for shallow, open pits, gouges, scratches, etc. which are less than 0.020 inch in depth.

(a) Cut Ladd No. 453 replicating tape to appropriate size.

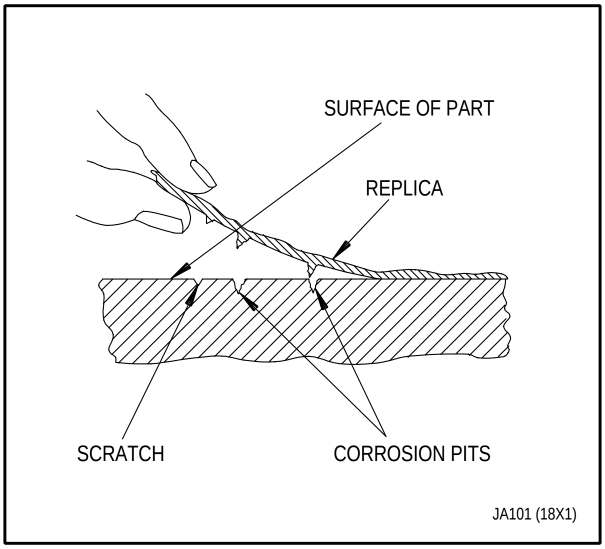


Figure 1. Replication

(b) Liberally moisten area to be inspected, using Ladd No. 451 replicating solution or O-A-51 acetone.

(c) While surface is still wet, apply replicating tape to damaged surface, working from center toward edges to force air out and tape into surface depressions.

(d) Allow tape to dry thoroughly (minimum 10 minutes).

(e) Lift replica from surface. If replica tends to tear, reinforce with cellophane tape.

(2) Replicating silicone rubber (SPOP 127).

NOTE

This inspection procedure is suitable for pits, gouges, scratches, etc. which exceed 0.010 inch diameter or 0.005 inch depth.

(a) Measure RTV 21 silicone rubber fluid and Nuocure 28 hardener into a clean container in the ratio of 1.5 to 2.0 ounces by weight RTV 21, to 8 to 10 drops Nuocure 28.

(b) Mix thoroughly.

(c) Apply a thin, even layer not thicker than 1/32 inch over the area to be replicated.

(d) Allow replica to cure completely (normally 45 to 60 minutes). Lift carefully from surface.

(3) Eutectic alloy.

NOTE

This is a low melting alloy composed of a mixture of bismuth, cadmium, lead and tin.

(a) Form a molded ring of low melting point alloy stop-off compound around pitted area.

(b) Heat eutectic alloy until melted, approximately 160°F (71°C); then pour into area within molded ring.

(c) Allow to cool and solidify; then peel off replica.

c. Inspect replica for dirt, scale, discoloration or air bubbles. Discard replica and prepare a new one if any of these conditions exist.

d. Examine replica by optical comparator or by microscope.

(1) Optical comparator (shadowgraph).

(a) Attach replica to round rod with contact side up.

(b) Mount rod on stage of optical comparator in fixture which allows rotation of rod.

(c) Adjust comparator stage so that light source radiates across top of rod and replica, casting shadow on screen.

(d) Set comparator for suitable magnification, such as 50X and focus image on screen.

(e) Slowly rotate rod until a condition of interest has a maximum size on screen. Measure size from screen and convert to actual size.

(2) Microscope.

(a) Measure width of feature of interest using calibrated scale.

(b) Measure height of replicated depression by calibrated focus adjustments.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES - INSPECTION, ULTRAHIGH SUPERSENSITIVE FLUORESCENT PENETRANT (SPOP 776)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Developer	D-100 Dubl-Chek
Penetrant, fluorescent	Zyglo ZL30
Penetrant, fluorescent	Zyglo ZLH
Remover, penetrant	Magnaflux HRH
Wetting agent (PMC 1622)	Orvus WA

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for ultrahigh supersensitive fluorescent penetrant inspection of blended areas on parts.

2. PROCEDURE (SPOP 776).

NOTE

Special penetrant mixture is composed of 60 ml Magnaflux ZL30, 50 ml Magnaflux ZLH, and two drops of PMC 1622 wetting agent, mixed thoroughly to assure no separation.

a. Apply special penetrant mixture on blend area to be inspected, and allow to stand 30 minutes.

b. Rinse part under running water at 70‘±5‘F (21‘±3‘C) and a pressure not more than 30 psig.

c. Swab with Magnaflux HRH remover in a circular motion over entire blended area, using a cotton swab. Go immediately to next step.

d. Warmup blacklight for a minimum of 10 minutes.

e. Rinse part under running water at 70‘±5‘F (21‘±3‘C) and a pressure not more than 30 psig. Swab inspection area during rinsing, and monitor penetrant removal using a black light.

f. Air dry at a temperature not more than 130‘F (55‘C), until thoroughly dry.

g. Spray Sherwin D-100 Dubl-Chek developer in a thin, even coat on blended area, and allow to stand 3 to 5 minutes before inspecting.

h. Inspect for cracks using a black light, in a darkened room. Reject part with crack indications.

i. If questionable indications appear, repeat steps g. and h.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, FLUORESCENT PENETRANT, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 10	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Inspection, Penetrant Method of	MIL-STD-6866
Introduction and General Information	T.O. 2J-F100-53-1
Marking, Temporary	SWP 023 01
Inspection, Fluorescent Penetrant, Normal Sensitivity (SPOP 62)	SWP 071 04
Inspection, Fluorescent Penetrant, Local Application (SPOP 70)	SWP 071 05
Inspection, Fluorescent Penetrant, High Sensitivity (SPOP 82)	SWP 071 06
Nondestructive Inspection Methods	T.O. 33B-1-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for fluorescent penetrant inspection.

2. GENERAL.

a. Fluorescent penetrant inspection is a nondestructive test for detecting surface cracks and flaws (discontinuities) in parts made of nonporous materials. It is intended to supplement, and not replace, a careful visual inspection.

b. Fluorescent penetrant inspection is a quick and positive method for detecting many types of defects. Its basic limitations are that discontinuities shall be open to the surface and free from any contamination. The general approach is as follows:

- A fluid (penetrant) is applied to the surface, entering the discontinuity
- Excess penetrant is removed, and penetrant remaining in the defect flows to the surface.
- Developer is applied, forming an indication which is made visible with ultraviolet light.

c. Fluorescent penetrant inspection methods shall be applied by trained, experienced personnel capable of evaluating the indications and judging whether parts are suitable for further service, require repair, or should be rejected.

d. Fluorescent penetrant inspection methods include Normal Sensitivity (T.O. 2J-F100-53-1, SWP 071 04), High Sensitivity (SWP 071 06), and Local Application (SWP 071 05). The high sensitivity method is particularly useful for turbine blades and vanes, and all highly stressed rotating parts.

e. Surfaces of parts requiring particular attention include the following:

- Lugs
- Bosses
- Webs
- Splines
- Teeth
- Flanges
- Cutouts
- Shoulders
- Slots
- Welds
- Brazed joints

f. The number, nature, and extent of discontinuities detected during fluorescent penetrant inspection shall be tabulated for evaluation against appropriate inspection standards. Disposition of parts containing discontinuities shall be made by experienced, designated personnel only. (Refer to T.O. 33B-1-1 and MIL-STD-6866.)

g. Explanation of terms:

Check - A tiny crack caused by grinding strain.

Crack - A break, fissure, or rupture, usually V-shaped and relatively narrow and deep.

Defect - A discontinuity which is detrimental to the serviceability of a part.

Discontinuity - An interruption in the normal physical structure or configuration of a part, such as a crack, seam, inclusion, or porosity. A discontinuity may or may not be detrimental to the serviceability of a part.

Emulsifier - A substance which has ability to cause two or more materials which would normally separate to combine. An example is soap, which causes the mixing of oil and water. In fluorescent penetrant testing, applying an emulsifier enables water rinsing of certain penetrant materials which are ordinarily insoluble in water.

Fatigue - The progressive fracture of a material which begins at a defect, and increases under repeated cycles of stress.

Hydrophilic - Mixing easily with waterbased liquids.

Inclusions - Particles of impurities, such as oxides, sulfides, or silicates, trapped in a metal casting as it solidifies from molten condition.

Indication - Evidence of a discontinuity or possible defect, obtained by nondestructive test.

Interpretation - Evaluation of the causes of indications and the significance of discontinuities as to whether they are due to detrimental defects or superficial (unimportant) blemishes.

Lipophilic - Mixing easily with oil-based liquids.

Post-emulsification - The technique of using a separate emulsifying step in preparing for water rinse removal of a penetrant.

Scratch - A shallow mark or injury produced by abrasion.

Water-washable - An oil-based penetrant which contains an emulsifying agent, making it washable by water rinsing.

3. SUMMARY OF METHODS.

NOTE

Refer to paragraph 7 for detailed description of fluorescent penetrant inspection procedures.

a. Fluorescent penetrant inspection can detect only defects which are open to the surface to allow entry of penetrant; therefore, surfaces shall be absolutely clean, and all deposits in and around discontinuities removed.

b. Cleaned parts are immersed in or sprayed with either a water washable or a post-emulsification penetrant.

c. Parts which were immersed or flood-sprayed in penetrant are then drained.

NOTE

There are two types of emulsifiers: lipophilic and hydrophilic. A lipophilic emulsifier combines rapidly with a penetrant. A hydrophilic emulsifier, however, does not combine readily with a penetrant. The emulsification period is therefore less critical with a hydrophilic emulsifier, and penetrant is less likely to be removed from a shallow discontinuity. Maximum brightness can also be obtained, since emulsifier does not tend to dilute penetrant in defects.

d. For parts using a post-emulsification penetrant, a separate emulsifier solution is applied.

e. Excess penetrant is removed by water washing.

f. Parts are dried, usually by application of warm, dry air.

g. Dry developer is dusted onto surface, or part is brushed, sprayed, or immersed in wet developer. Penetrant material in defects or discontinuities is drawn up and absorbed by developer, making penetrant more easily visible in ultraviolet light.

h. Parts are exposed to ultraviolet light and inspected for indications (location of discontinuities or defects).

i. Developer is brushed or rinsed off. Removal of residual material by post-cleaning is ordinarily not required.

4. MATERIALS.

(See Table 1.)

a. Authorized fluorescent penetrant materials are listed in table 1. All materials shall be used full strength except ZR10B emulsifier, which is a concentrate.

b. Dilute ZR10B hydrophilic emulsifier as follows:

(1) Fill 1/3 of operating volume of tank with ZR10B emulsifier.

(2) Fill remainder of operating volume of tank with clean water.

(3) When necessary, maintain operating level by adding to solution at ratio of two parts water to one part emulsifier.

5. EQUIPMENT.

a. For immersion and flood spray penetrant application, mild steel tanks large enough to accept largest parts are needed to hold penetrants and emulsifiers. Suitable drain trays shall be located adjacent to each tank.

b. A water spray rinse or dip bath tank capable of delivering water at temperatures from 55°F (13°C) to 140°F (60°C) are needed, depending on requirements of materials used.

Table 1. Authorized Fluorescent Penetrant Materials

Material	Designation
Water-washable penetrant	WP2H ZL15B ZL66
Post-emulsification penetrant	ZL37 ZL27A
Emulsifier	ZR10B
Dry powder developer	ZP4B
Wet developer	ZP9E

CAUTION

Use penetrant and emulsifier materials supplied by one manufacturer together as a group when performing a penetrant inspection process. Only qualified materials under MIL-I-25135 are authorized for use.

NOTE

Existing supplies of previously qualified, discontinued materials may be used up.

c. A drying oven with a thermostatically controlled recirculating warm air feature is necessary for each tank.

d. A dust storm cabinet or equivalent is required for applying dry developer powder.

NOTE

Large flood-type ultraviolet lighting can aid inspection of large parts before locally inspecting with a hand lamp.

e. A suitable ultraviolet lamp (black light) is a Westinghouse or GE mercury projector lamp No. CH-4 (spot) or EH-4 (flood), using a Kopp No. 41 filter or equivalent. A reactor-transformer shall be used between the lamp and the 110 volt current source.

6. MAINTENANCE OF EQUIPMENT AND MATERIALS.

a. Ultraviolet lamps and filters shall be checked every 30 days with a Weston Sight-Light Meter, Model 703, Type 3A or equivalent. Obtain proper range on meter using a ten-power multiplier disk. A visual correction filter shall not be used. Check lamp as follows:

(1) Turn on lamp for not less than 15 minutes to permit vapor to stabilize before making measurement.

(2) Install filter regularly used with lamp.

(3) Measure light intensity with meter held 12 inches from ultraviolet lamp.

(4) Replace lamp if light intensity is less than 200 foot-candles.

b. Penetrants and emulsifiers shall be tested at regular intervals, with frequency established according to use of materials. Test as follows:

(1) Retain a one or two pint specimen of each new batch of penetrant and emulsifier for comparison with used materials. Protect from direct sunlight or extreme temperatures.

(2) Test penetrant and emulsifier materials by processing aluminum test specimens (Magnaflux Corp. PN 14755, or equivalent). Apply new materials to 1/2 the test specimen, and used materials to the other half. Inspect both halves simultaneously.

(3) During washing operation, note ease with which penetrant is washed from parts.

(4) With test specimens under ultraviolet light, observe following:

- Brilliance of indications
- Extent to which very fine cracks are visible
- Extent to which indications are retained in wide cracks
- Amount of fluorescent background

(5) If brilliance is low, fine cracks are not shown, or wide cracks are washed out, replace penetrant material.

(6) If washing is difficult or fluorescent background is excessive, replace penetrant or emulsifier.

(7) If there is a negligible difference between inspection with new and used materials, penetrant or emulsifier shall be considered satisfactory.

7. FLUORESCENT PENETRANT INSPECTION PROCEDURES.

a. Fluorescent penetrant inspection procedures and materials are specified by SPOP Number. Each part which requires fluorescent penetrant inspection is identified in the applicable WP with the SPOP to be used in inspecting that part. Refer to T.O. 2J-F100-53-1, SWP 071 04 (SPOP 62 - Normal Sensitivity), SWP 071 05 (SPOP 70 - Local Application), and SWP 071 06 (SPOP 82 - High Sensitivity) for specific inspection requirements.

b. Surface preparation.

(1) Thoroughly clean each part to be inspected. Surfaces shall be free of foreign material including cleaning agents, particularly alkaline (caustic) cleaners. Residual cleaners might prevent adequate penetration of discontinuities, or might hold penetrant and cause nonrelevant indications. Removal of paint by volatile solvents is not recommended because solvent may carry dissolved or loosened paint into discontinuities, thus preventing adequate penetration by fluorescent penetrant.

(2) Remove oil by degreasing. Remove dirt and scale by chemical or mechanical cleaning. Any blast cleaning procedure shall be of a type which will not smear over or close up surface openings.

c. Penetration.

(1) Apply fluorescent penetrant by brushing, spraying, or immersion. Penetrant is drawn into defects by capillary action. Parts shall be drained after immersion, with time on drain rack included in penetration time. If penetration time is exceeded, penetrant shall be reapplied.

(2) Cover penetrant on part with emulsifier where applicable.

d. Washing. After penetration time has elapsed, penetrant (and emulsifier, if used) shall be washed off with cold water or warm water at 120° to 140°F (49° to 60°C) or as specified.

(1) A combination of dipping and spraying may be used.

(2) Use of spray nozzle is essential, as physical action of water droplets hastens the emulsifying process.

(3) Water may be removed by a mild air blast prior to drying.

(4) Check wash water under ultraviolet light to assure complete removal of penetrant.

(5) If allowed time is exceeded for combined emulsification and washing process, inspection procedure shall be repeated from the beginning.

e. Drying. Oven dry for specified time interval to permit development of fluorescent indications.

(1) Drying time in recirculating hot air dryer varies, depending on size and shape of part.

(2) Excessive drying time or temperature interferes with development of adequate indications.

(3) Allow parts to cool to a temperature at which they can be comfortably handled without gloves.

f. Developing.

(1) Dry developers are powder preparations which may be applied by immersion in the dry powder, brushing, or low-pressure air spraying. Dry developer shall be light and fluffy; easily applied in thin, even coats; capable of masking out interfering background colors; easily wet by the penetrant; readily removable; and neither toxic nor harmful to the operator.

(2) Wet developers are liquid preparations with liquid absorbing characteristics. Wet developer is applied by immersion, brushing, or spraying. The part shall then be allowed to dry in air or in a controlled recirculating warm air dryer. Wet developer shall be readily removable and neither toxic nor harmful to the operator.

g. Inspection.

CAUTION

Eyeglasses with light-sensitive lenses shall not be worn during fluorescent penetrant inspection. When exposed to ultraviolet (black) light, up to 50% loss in visual acuity may occur due to loss in light transmission through these lenses.

(1) Parts shall be inspected with ultraviolet light in a darkened area or booth unless specified otherwise. Small parts may be held under a fixed light. Use a portable hand light over surface of large parts. Discontinuities will be shown by fluorescence of penetrant where it has developed out of flaws. Where required, use a magnifying glass of 4X to 10X.

(2) Circle indications and questionable areas using an approved temporary marking method. (Refer to T.O. 2J-F100-53-1, WP 023 01.) Disposition of parts which contain discontinuities, as indicated by fluorescent penetrant inspection, shall be made by experienced, designated personnel only.

(3) Allow adequate time for marks to dry before handling parts. Clean parts before proceeding with further processing.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, FLUORESCENT PENETRANT, NORMAL SENSITIVITY (SPOP 62)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, butyl	TT-B-848
Alcohol, propyl	-
Developer, dry	ZP4B
Developer, wet	ZP9E
Oil, corrosion preventive	MIL-C-15074
Penetrant, fluorescent	ZL15B or WP2H
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for inspection by the normal sensitivity fluorescent penetrant procedure (SPOP 62).

2. NORMAL SENSITIVITY FLUORESCENT PENETRANT INSPECTION.

(See Table 1.)

a. The following fluorescent penetrant procedure uses the water wash system.

CAUTION

Eyeglasses with light-sensitive lenses shall not be worn during fluorescent penetrant inspection. When exposed to black light, up to 50% loss in visual acuity may occur due to loss in light transmission through these lenses.

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	NOTE For parts other than titanium alloy, proceed to Operation 2.				
1	(For titanium alloy parts) a. Degrease, if required, using a clean cloth moistened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol. b. Proceed to Operation 3.	2.0 to 5.0		Room	Room

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
2	(For parts other than titanium alloy). Vapor degrease as follows:				

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921 and then only if specified in WP/SWP. Degreasing fluid can cause stress corrosion in titanium alloys.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	a. Lower part slowly (no more than 2.2 inches per second) into vapor region. Suspend until condensation stops.	0.5	O-T-236 tetrachloroethylene (perchlorethylene)	248 to 256	120 to 125
			Alternate: MIL-T-81533 trichloroethane	162 to 170	72 to 77
	b.(Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.	2.0 to 8.0	-	-	-
	c. Raise part out of vapor slowly (no more than 2.2 inches per second). Drain only until dry.	0.5 to 1.0	-	-	-
	d. Allow part to cool until it can be safety handled without gloves.				

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
3	Mask or plug internal passages as required.	2.0 to 4.0	-	-	-
4	Spray, brush on, or immerse completely in penetrant.	1.0 to 2.0	ZL15B penetrant or WP2H penetrant	-	-

NOTE

If drainage time exceeds 60 minutes, reapply penetrant per Operation No. 4

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	Drain, rotating parts if necessary to facilitate drainage.	10 to 30	-	-	-
6	a. Wash with a fine water spray (40 psi maximum) or in water bath. b. Flush interior passages with small tube until water runs clear. Immediately remove water from all parts subject to corrosion pitting. c. Remove excess water with blast of low pressure filtered air (30 psig max).	3.0 maximum	Water	55 to 85	13 to 29

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
7	Check thoroughness of wash under ultraviolet light.	0.5 to 1.0	-	-	-
8	Wet developer (For alternate dry developer method, see Operation 9.)				
	a. Immerse, spray, or brush with wet developer.	0.25 maximum	ZP9E wet developer	-	-
	b. Drain, positioning parts for optimum drainage. Do not air blow.	10 maximum	-	-	-

NOTE

Excessive drying time or temperature interferes with development of adequate indications.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	c. Dry in an oven.	-	*Oven temperature	180* maximum	82* maximum
	d. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	e. Proceed to Operation 10.				

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
9	Dry developer (Alternate to Operation 8.)				
	NOTE Excessive drying time or temperature interferes with development of adequate indications.				
	a. Dry in an oven.	-	*Oven temperature	180* maximum	82* maximum
	b. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	NOTE For aluminum or magnesium castings, allow 10 to 30 minutes for penetrant to bleed from discontinuities before inspecting. Instead of dusting all over, apply developer to questionable indications only.				
	c. Dust all over with dry developer and allow for absorption of penetrant.	10 minimum	ZP4B dry developer	-	-
	NOTE Complete inspection within 90 minutes after applying developer. Indications beginning to appear only after 90 minutes shall be considered doubtful.				
10	a. Examine under ultraviolet light.	-	-	-	-
	b. Mark indications and questionable areas.	-	-	-	-

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
11	Process any area showing moderate fluorescent background, or any marginally unacceptable or questionable indications as follows:	-	-	-	-
	a. (For all parts other than titanium alloy).				
	Lightly stroke suspect area with soft brush dampened with O-A-51 acetone, MIL-T-81533 degreasing solvent, or equivalent. Do not permit liquid to run over or flood any surface. (Proceed to step c.)	-	-	-	-
	b. (For titanium alloy parts)				
	Lightly stroke suspect area with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.				
	c. Allow solvent to evaporate from surface.	-	-	-	-

Table 1. Normal Sensitivity Fluorescent Penetrant Inspection (SPOP 62) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
12	a. (Wet developer method.)	-	-	-	-
	Repeat Operation 8 as required.				
	b. (Dry developer method.)	-	-	-	-
	Repeat Operation 9 as required.				

NOTE

If total processing time from application of penetrant to completion of inspection exceeds 3 hours, or if parts exhibit excessive background fluorescence due to processing problems, parts shall be reprocessed beginning with Operation 1.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
13	Examine under ultraviolet light.				
	a. If indication reappears immediately, evaluate immediately.	-	-	-	-
	b. If indication does not reappear immediately, allow a minimum of 5 minutes for redevelopment, then re-examine.	-	-	-	-
14	Preserve with corrosion preventive compound as required.	-	MIL-C-15074	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, FLUORESCENT PENETRANT, LOCAL APPLICATION (SPOP 70)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Alcohol, butyl	TT-B-848
Alcohol, propyl	-
Cleaner, fluorescent penetrant	ZC7B
Cloth, wiping	-
Developer, dry	ZP4B
Developer, wet developer	ZP9E
Methyl ethyl ketone	TT-M-261
Oil, corrosion preventive	MIL-C-15074
Penetrant, fluorescent	ZL22C
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for inspection using a local application fluorescent penetrant procedure (SPOP 70).

2. LOCAL APPLICATION FLUORESCENT PENETRANT INSPECTION.

(See Table 1.)

a. The following procedure uses a post-emulsification penetrant with an aqueous remover.

CAUTION

Eyeglasses with light-sensitive lenses shall not be worn during fluorescent penetrant inspection. When exposed to ultraviolet (black) light, up to 50% loss in visual acuity may occur due to loss in light transmission through these lenses.

Table 1. Local Application Fluorescent Penetrant Inspection (SPOP 70)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	NOTE For parts other than titanium alloy, proceed to Operation 2.				
1	(For titanium alloy parts)				
	a. Clean thoroughly to remove all soils and oil. Use a clean cloth moistened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.	2.0 to 5.0		Room	Room
	b. Proceed to Operation 3.				

Table 1. Local Application Fluorescent Penetrant Inspection (SPOP 70) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
2	(For all parts other than titanium alloys)				
	Clean thoroughly to remove all soils and oil. Spray on cleaner or degreasing solvent and wipe with cloth, or vapor degrease as follows:	2.0 to 5.0	ZC7B cleaner or MIL-T-81533 cloth	Room	Room

CAUTION

Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified in WP/SWP. Degreasing fluid can cause stress corrosion in titanium alloys.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	a. Lower part slowly (no more than 2.2 inches per second) into vapor region. Suspend until condensation stops.	0.5	O-T-236 tetrachloroethylene (perchloroethylene)	248 to 256	120 to 125
			Alternate: MIL-T-81533 trichloroethane	162 to 170	72 to 77
	b. (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.	2.0 to 8.0	-	-	-

Table 1. Local Application Fluorescent Penetrant Inspection (SPOP 70) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
2 (cont'd)	(For all parts other than titanium alloys)				
	c. Raise part out of vapor slowly (no more than 2.2 inches per second). Drain only until dry.	0.5 to 1.0	-	-	-
	d. Allow part to cool until it can be safely handled without gloves.				
3	Mask area surrounding each region being inspected.	2.0 to 4.0	Masking tape	-	-
4	Apply penetrant with a brush, cloth, or cotton swab, and allow to penetrate.	15 minimum to 30 maximum	ZL22C penetrant	-	-

NOTE

For parts other than titanium alloy, proceed to Operation 6.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	(For titanium alloy parts)				
	a. Wipe surfaces with a cloth or paper wipe to remove penetrant. Moisten wiper with methyl ethyl ketone if necessary.	-	TT-M-261	-	-
	b. Proceed to Operation 7				

Table 1. Local Application Fluorescent Penetrant Inspection (SPOP 70) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
6	(For all parts other than titanium alloys) Wipe surfaces with a cloth or paper wipe to remove penetrant. Moisten wiper with cleaner or degreasing solvent if necessary.	-	ZC7B cleaner or MIL-T-81533	-	-
7	Very lightly (one pass only) apply wet or dry developer on part. Allow 10 minutes minimum for development.	11	ZP9E wet developer or ZP4B dry developer	-	-

NOTE

Due to the brightness of this penetrant, inspection can be done under normal lighting conditions.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
8	Examine under ultraviolet light.	-	-	-	-

CAUTION

- Ensure all traces of penetrant are removed to prevent corrosion of parts.
- Ensure penetrant does not become entrapped in blind pockets or passages, otherwise corrosion may occur.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
9	Remove developer by brushing with a cloth.	-	cloth	-	-
10	Preserve with corrosion preventive compound as necessary	-	MIL-C-15074	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, FLUORESCENT PENETRANT, HIGH SENSITIVITY (SPOP 82)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 20

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 19	0				
20 Blank	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Inspection Materials, Penetrant	- - - - - - - - - - - - - - - - -	MIL-I-25135

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Developer, Dry or wet	MIL-I-25135, Type I
Emulsifier, hydrophilic or lipophilic	MIL-I-25135, Type I, Method C or D
Oil, corrosion preventive	MIL-C-15074
Penetrant, post emulsifiable	MIL-I-25135, Type I, Method D
Penetrant, water washable, high sensitivity	MIL-I-25135, Type I, Method A
Solvent, degreasing	O-T-236 or MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for inspection by the high sensitivity fluorescent penetrant procedure (SPOP 82).

2. HIGH SENSITIVITY FLUORESCENT PENETRANT INSPECTION

(See Table 1.)

a. The fluorescent penetrant procedure described in table 1 uses either a water wash system, Method A, or a post-emulsification system, Method B.

(1) The high sensitivity water wash system (Method A) is restricted to inspection of welds and non-rotating parts.

(2) When Method B (post-emulsification) is selected, a further option is provided for either a hydrophilic or lipophilic emulsifier.

(3) Penetrants for either system may be applied using electrostatic equipment.

b. Penetrant and emulsifier shall be selected as a group from same manufacturer (family concept), wherever possible.

CAUTION

Eyeglasses with light-sensitive lenses shall not be worn during fluorescent penetrant inspection. When exposed to ultraviolet (black) light, up to 50% loss in visual acuity may occur due to loss in light transmission through these lenses.

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	METHOD A - WATER WASH SYSTEM				
	NOTE For parts other than titanium alloy, proceed to Operation 2.				
1	(For titanium alloy parts)				
	a. Degrease, if required, using a clean cloth moistened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.	2.0 to 5.0		Room	Room
	b. Proceed to Operation 3.				
2	(For parts other than titanium alloy)				
	Vapor degrease, if required, as follows:	-	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	CAUTION Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified in WP. Degreasing fluid can cause stress corrosion in titanium alloys.				
2 (cont'd)	a. Lower part slowly (no more than 2.2 inches per second) into vapor region. Suspend until condensation stops.	0.5	O-T-236 tetrachloroethylene (perchlorethylene)	248 to 256	120 to 125
			Alternate: MIL-T-81533 trichloroethane	162 to 170	72 to 77
	b. (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.	2.0 to 8.0	-	-	-
	c. Raise part out of vapor slowly (no more than 2.2 inches per second). Drain only until dry.	0.5 to 1.0	-	-	-
	d. Allow part to cool until it can be safely handled without gloves.				
3	Mask or plug internal passages as required.	2.0 to 4.0	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
4	Spray, brush on, or immerse completely in water-washable penetrant.	1.0 to 2.0	MIL-I-25135 Type I, Method A	Room	Room
	NOTE If drainage time exceeds 60 minutes, reapply penetrant per Operation 4.				
5	Drain, rotating parts if necessary to facilitate drainage.	10 to 30	-	-	-
	NOTE Wash time for compressor blades shall be limited to 2 minutes maximum.				
6	a. Wash with a fine water spray (40 psig maximum) or dip bath. b. Flush interior passages with small tube until water runs clear. Immediately remove water from all parts subject to corrosion pitting. c. Remove excess water with a blast of low pressure filtered air (30 psig max).	3.0 maximum	Water	55 to 85	13 to 29

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
7	Check thoroughness of wash under ultraviolet light.	0.5 to 1.0	-	-	-
8	Wet Developer (For alternate, see Operation 9.)				
	a. Immerse, spray, or brush with wet developer.	0.25 maximum	MIL-I-25135, Type I	-	-
	b. Drain, positioning parts for optimum drainage. Do not air blow.	10 maximum	-	-	-

NOTE

Excessive drying time or temperature interferes with development of adequate indications.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	c. Dry in an oven.		*Oven temperature	180* maximum	82* maximum
	d. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	e. Proceed to Operation 10.				

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
9	Dry Developer (Alternate to Operation 8.)				

NOTE

Excessive drying time or temperature interferes with development of adequate indications.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	a. Dry in an oven.	-	*Oven temperature	180* maximum	82* maximum
	b. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	c. Dust all over with dry developer and allow for absorption of penetrant.	10 minimum	MIL-I-25135, Type I	-	-

NOTE

- Complete inspection under ultraviolet light within 60 minutes after applying developer.
- Indications beginning to appear only after 60 minutes shall be considered doubtful.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
10	a. Examine under ultraviolet light.	-	-	-	-
	b. Mark indications and questionable areas.	-	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
11	Process any area showing moderate fluorescent background, or any marginally unacceptable or questionable indications as follows:	-	-	-	-
	a. (For all parts other than titanium alloy)				
	Lightly stroke suspect area with soft brush dampened with O-A-51 acetone, MIL-T-81533 trichloroethane degreasing solvent, or equivalent. Do not permit liquid to run over or flood any surface. (Proceed to step c.)	-	-	-	-
	b. (For titanium alloy parts)				
	Lightly stroke suspect area with soft brush dampened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.				
	c. Allow solvent to evaporate from surface.	-	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
12	(Wet developer method) Repeat Operation 8, as required.	-	-	-	-
13	(Dry developer method) Repeat Operation 9, as required.	-	-	-	-

NOTE

If total processing time from application of penetrant to completion of inspection exceeds 3 hours, or if parts exhibit excessive background fluorescence due to processing problems, parts shall be reprocessed beginning with Operation 1.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
14	Examine under ultraviolet light. a. If indication reappears immediately, evaluate immediately. b. If indication does not reappear immediately, allow a minimum of 5 minutes for redevelopment, then re-examine.	-	-	-	-
15	Preserve with corrosion preventive compound as required.	-	MIL-C-15074	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
METHOD B - POST-EMULATION SYSTEM NOTE					
For parts other than titanium alloy, proceed to Operation 2.					
1	(For titanium alloy parts)				
	a. Degrease, if required, using a clean cloth moistened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.	2.0 to 5.0		Room	Room
	b. Proceed to Operation 3.				
2	(For all parts other than titanium alloy)				
	Vapor degrease, if required, as follows:	-	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	CAUTION Do not vapor degrease titanium parts except AMS 4901 or AMS 4921, and then only if specified in WP. Degreasing fluid can cause stress corrosion in titanium alloys.				
2 (cont'd)	a. Lower part slowly (no more than 2.2 inches per second) into vapor region. Suspend until condensation stops.	0.5	O-T-236 Tetrachloroethylene (perchlorethylene)	248 to 256	120 to 125
			Alternate: MIL-T-81533 trichloroethane	162 to 170	72 to 77
	b. (Optional) Spray degreasing fluid onto part. Do not hold nozzle above vapor region.	2.0 to 8.0	-	-	-
	c. Raise part out of vapor slowly (no more than 2.2 inches per second). Drain only until dry.	0.5 to 1.0	-	-	-
	d. Allow part to cool until it can be safely handled without gloves.				
3	Mask or plug internal passages as required.	2.0 to 4.0	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
4	Hydrophilic Emulsification (For alternate, see Operation 5.)				
	a. Spray, brush on, or immerse completely in penetrant.	1.0 to 2.0	MIL-I-25135 Type I, Method D, Level 3 or 4	Room	Room

NOTE

It is preferable to drain no more than 30 minutes. If drainage time exceeds 60 minutes, reapply penetrant per step a.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	b. Drain, rotating parts if necessary, to facilitate drainage.	10 to 60 maximum	-	-	-
	c. Water spray rinse.				
	d. Remove excess water with blast of clean, compressed air.	0.2 to 0.5	Water	Room	Room

NOTE

Emulsifier immersion time for compressor blades shall be limited to one minute maximum.

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
4 (cont'd)	Hydrophilic Emulsification				
	e. Immerse completely in hydrophilic emulsifier solution. Provide mild, continuous agitation of solution.	1.75 maximum	*MIL-I-25135, Type I, Method D, Level 3 or 4 *Dilute emulsifier concentrate with clean water, as applicable, per manufacturer's instructions. When required, maintain operating level by adding to solution at original dilution ratio.	Room	Room
	f. Wash using a fine spray (40 psig maximum), or in water bath.	1.75 maximum	Water	55 to 85	13 to 29
	g. Flush interior passages with small tube until water runs clear. Immediately remove water from all parts subject to corrosion pitting.				
	h. Remove excess water with blast of low pressure filtered air.				
	i. Proceed to Operation 6.				

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	Lipophilic Emulsification (Alternate to Operation 4)				
	a. Spray, brush, or immerse completely in penetrant.	1.0 to 2.0	MIL-I-25135, Type I, Method B, Level 3 or 4	Room	Room

NOTE

It is preferable to drain longer than 30 minutes. If drainage time exceeds 60 minutes, reapply penetrant per step a.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	b. Drain, rotating parts if necessary to facilitate drainage.	10 to 60 maximum	-	-	-
	c. Immerse completely in lipophilic emulsifier solution.	0.5 to 1.0	MIL-I-25135, Type I, Method B, Level 3 or 4	Room	Room

NOTE

Total combined time for emulsifier immersing and draining shall not exceed 1 minute for compressor blades, or 2 minutes for any other part.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	d. Drain.	0.5 to 1.0	-	-	-

NOTE

Wash time for compressor blades shall be limited to 2 minutes maximum.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	e. Wash with a fine water spray (40 psig maximum) or in water bath.	3.0 maximum	Water	140 maximum	60 maximum

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5 (cont'd)	Lipophilic Emulsification				
	f. Flush interior passages with small tube until water runs clear. Immediately remove water from all parts subject to corrosion pitting.				
	g. Remove excess water with blast of low pressure filtered air.				
6	Check thoroughness of wash under ultraviolet light.	0.5 to 1.0	-	-	-
7	Wet Developer (For alternate, see Operation 8.)				
	a. Immerse, spray, or brush with wet developer.	0.25 maximum	MIL-I-25135, Type I	-	-
	b. Drain, positioning parts for optimum drainage. Do not air blow.	10 maximum	-	-	-
	NOTE Excessive drying time or temperature interferes with development of adequate indications.				
	c. Dry in an oven.	-	*Oven temperature	180* maximum	82* maximum
	d. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	e. Proceed to Operation 9				

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
8	Dry Developer (Alternate to Operation 7.)				

NOTE

Excessive drying time or temperature interferes with development of adequate indications.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	a. Dry in an oven.	-	*Oven temperature	180* maximum	82* maximum
	b. Remove parts from oven as soon as surfaces are dry, but not too hot to handle without gloves.	-	-	-	-
	c. Dust all over with dry developer and allow for absorption of penetrant.	10 minimum	MIL-I-25135, Type I	-	-

NOTE

- Complete inspection under ultraviolet light within 60 minutes after applying developer.
- Indications beginning to appear only after 60 minutes shall be considered doubtful.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
9	a. Examine under ultra-violet light.	-	-	-	-
	b. Mark indications and questionable areas.	-	-	-	-

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
10	Process any area showing moderate fluorescent background, or any marginally unacceptable or questionable indications as follows:	-	-	-	-
	a. (For all parts other than titanium alloy)				
	Lightly stroke suspect area with soft brush dampened with O-A-51 acetone, MIL-T-81533 trichloroethane degreasing solvent, or equivalent. Do not permit liquid to run over or flood any surface. (Proceed to step c.)	-	-	-	-
	b. (For titanium alloy parts)				
	Lightly stroke suspect area with soft brush dampened with, in order of preference, propyl alcohol or TT-B-848 butyl alcohol.				
	c. Allow solvent to evaporate from surface.				

Table 1. High Sensitivity Fluorescent Penetrant Inspection (SPOP 82) (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
11	(Wet developer method) Repeat Operation 7, as required.	-	-	-	-
12	(Dry developer method) Repeat Operation 8, m as required.	-	-	-	-

NOTE

If total processing time from application of penetrant to completion of inspection exceeds 3 hours, or if parts exhibit excessive background fluorescence due to processing problems, parts shall be reprocessed beginning with Operation 1.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
13	Examine under ultraviolet light.				
	a. If indication reappears immediately, evaluate immediately.	-	-	-	-
	b. If indication does not reappear immediately, allow a minimum of 5 minutes for redevelopment, then re-examine.	-	-	-	-
14	Preserve with corrosion preventive compound as required.	-	MIL-C-15074	-	-

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, MAGNETIC PARTICLE, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 11	0				
12 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Inspection Process, Magnetic Particle	MIL-STD-1949
Introduction and General Information	T.O. 2J-F100-53-1
Marking, Temporary	SWP 023 01
Inspection, Magnetic Particle (SPOPS 101 through 118)	WP 073 00
Nondestructive Inspection Methods	T.O. 33B-1-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Magnetic particle suspension, fluorescent	Magnaglo Powder No. 14A or Testing Systems Powder No. C-29F
Oil, inspection, ordorless	AMS 3161
Oil, lubricating	MIL-7808
Solvent, petroleum	P-D-680, Type II or Exxon Isopar M

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for magnetic particle inspection.

2. GENERAL.

a. Magnetic particle inspection is a rapid nondestructive method of detecting imperfections at or near the surface of steel parts. The method is intended to supplement, and not replace, a careful visual inspection.

b. Magnetic particle inspection relys on a magnetic field which is established when a part is magnetized. A defect will interrupt this field, attracting magnetic particles which outline the indication.

c. In addition to cracks, other defects which can be detected by this method include seams, laps, folds, and nonmetallic surface or near-surface inclusions.

d. Magnetic particle inspection methods shall be applied by trained, experienced personnel capable of correctly evaluating the indications and judging whether parts are suitable for further service, require repair, or should be rejected.

e. Magnetic particle inspection includes the following methods: (Refer to T.O. 2J-F100-53-1, WP 073 00 for inspection procedures for each SPOP.)

(1) Rod magnetization (SPOP 101).

(2) Rod and solenoid magnetization (SPOP 102).

(3) Rod and OD contact magnetization (SPOP 103).

(4) End contact magnetization (SPOP 105).

(5) End contact and solenoid magnetization (SPOP 106).

(6) Solenoid magnetization (SPOP 107).

(7) Shaft magnetic particle inspection (SPOP 108).

(8) Disk magnetic particle inspection (SPOP 112).

(9) Rod and induction (fixture or cable) magnetization (SPOP 115)

(10) Induction (fixture or cable) and solenoid magnetization (SPOP 116).

(11) Case magnetic particle inspection (SPOP 117).

(12) Vane and shroud magnetic particle inspection (SPOP 118).

f. Parts which require magnetic particle inspection shall be inspected completely, with special attention given to:

- Lugs
- Bosses
- Webs
- Splines
- Teeth
- Flanges
- Shoulders
- Slots
- Any intricate configuration

g. Inspection WPs specify methods to be used, sequence of magnetization, amperages, inspection limits, and applicable special tools. Unless otherwise specified, inspection procedures apply to the direct current wet residual magnetization method.

h. Alternating current continuous magnetization is approved, however operator shall be reponsible for development of equivalent amperages and procedures. The induced current method of magnetization, using a circular part as a shorted turn, is also approved.

i. Magnetic particle inspection includes tabulation of the number, nature, and extent of discontinuities detected. Refer to T.O. 33B-1-1 and MIL-STD-1949.

j. Explanation of terms:

Amperage numbers - Amperages provided in the Inspection WPs to be used in the specified magnetic particle inspection method for engine part. First, second, third, etc refer to the consecutive order of use.

Carbide segregation - Discontinuity caused by reaction of carbon with metal, and classified as an inclusion.

Check - A tiny crack caused by grinding strain.

Continuous method - Magnetic particle inspection while magnetizing current is held on.

Crack - A break, fissure, or rupture, usually V-shaped and relatively narrow and deep.

Defect - A discontinuity which is detrimental to the serviceability of a part.

Discontinuity - An interruption in the normal physical structure or configuration of a part, such as a crack, seam, inclusion, or porosity. A discontinuity may or may not be detrimental to the serviceability of a part.

Draw marks - Lines or markings on formed, drawn, or extruded metal parts caused by imperfections in the surface of the die, or by scoring, galling, or pickup. Usually of a minor or nondetrimental nature.

Fluorescent magnetic particle inspection - The use of a material which contains a fluorescent agent as well as magnetic particles.

Grind marks - Shallow imperfections in surface texture left by grinding tool. Usually of a minor or nondetrimental nature.

Imperfection - Any irregularity of material inspected, sufficient to produce a nondestructive test indication.

Inclusions - Particles of impurities, such as oxides, sulfides, or silicates, trapped in a metal casting as it solidifies from the molten condition, or formed by subsequent chemical reaction by the solid metal.

Indication - Evidence of a discontinuity or possible defect, obtained by nondestructive test.

Interpretation - Evaluation of the causes of indications and the significance of discontinuities as to whether they are due to detrimental defects or superficial (unimportant) blemishes.

Magnetic flux leakage - Disruption of magnetic lines of force, caused by the creation of north and south poles on either side of a crack or discontinuity. Results in a magnetic particle indication.

Nick - A sharp indentation caused by metal striking a part, such as foreign object damage during engine operation, or handling accident during assembly or disassembly.

Residual method - A magnetic particle technique in which inspection is accomplished after magnetizing current has been shut off.

Scratch - A shallow mark or injury produced by abrasion.

3. SUMMARY OF METHOD.

NOTE

Refer to paragraph 6 for detailed description of magnetic particle inspection procedures.

a. Clean part.

b. Magnetize part directly by passing electric current through part, or indirectly by placing part in a magnetic field.

c. Immerse magnetized part in a suspension containing finely divided magnetic particles. Particles accumulate wherever imperfections cause magnetic flux leakage.

d. Evaluate and interpret pattern, and record results.

e. Demagnetize, clean, and preserve part.

4. EQUIPMENT.

CAUTION

Equipment which may arc and cause burning of engine parts shall not be used. If a part is burned, determine cause and take corrective action.

a. Equipment shall have sufficient capacity to produce required amperage. Fixtures, adapters, and conducting rods shall be used as required to properly inspect parts.

b. A special combination induced current and knife switch coil fixture, Magnaflux model X-2152 (manufactured by Magnaflux Corporation 7300 W. Lawrence Avenue, Chicago, IL 60656) or equivalent, may be used for induced current method of magnetization.

c. Alternate equipment which may be used for steel compressor blades is the Magnaflux Duovec Machine, model MV-1733, or equivalent.

d. Solenoid coils needed, depending on size of parts, are as follows:

Magnaflux Part Number	Diameter, Inches
74610	2
74615	4
74620	6
74625	8
74630	10
74635	12

e. Tanks of sufficient size to accommodate parts being inspected shall be used to hold suspension.

f. Equipment shall be checked daily for loose connections or grounds, short circuits, and proper operation. Ammeters shall be checked monthly for accuracy.

g. A test part with known defects shall be checked daily to determine that satisfactory results are obtained. Make any necessary repairs or adjustments before inspecting engine parts.

5. MATERIALS.

a. Magnetic substance for fluorescent magnetic particle inspection shall be an oil suspendable material such as Magnaglo Powder No. 14A (manufactured by the Magnaflux Corporation), or Testing Systems Powder No. C-29F (manufactured by Testing Systems, Inc, 2826 Mt Carmel Ave, Glenside, PA 19038), or equivalent.

b. Magnetic substance shall be suspended in P-D-680, Type II petroleum solvent or AMS 3161 odorless inspection oil. During use, suspension shall be agitated in order to maintain a uniform mixture and minimize settling.

c. Suspension in each tank shall be checked periodically for contamination by foreign materials. Since contamination will be in proportion to amount of use, test frequency may vary but shall be accomplished at least once every three months.

d. Suspension in each tank shall be checked at least once during each 8 hour period of use, for concentration of magnetic substance as follows:

(1) Scrape bottom of tanks at beginning of 8 hour period to loosen settled material.

(2) At least 1 hour after scraping, fill clean 100 ml graduated centrifuge tubes to the 100 ml mark with samples from each tank, and demagnetize.

(3) Allow contents to stand for 30 minutes. Tap sides of centrifuge tube lightly to level settled material.

(4) Volume of fluorescent magnetic powder shall be not less than 0.1 ml or more than 0.5 ml. If less than 0.1 ml, make appropriate addition to tank.

(5) Total addition of all material to suspension shall not raise viscosity above 5.0 centistokes (42.5 SUS) at any temperature at which the bath is used.

6. MAGNETIC PARTICLE INSPECTION PROCEDURES.

a. Magnetic particle inspection requirements are specified by SPOP number. Parts which require magnetic particle inspection are identified in the applicable WP with the SPOP to be used in inspecting each part. Refer to T.O. 2J-F100-53-1, WP 073 00 for specific inspection requirements.

b. Preparation of parts.

(1) Disassemble and thoroughly clean all parts.

(2) Cap all oil passages.

(3) Remove all scratches, scoring, and galling with stones or crocus cloth and oil. Polish contact areas of all parts to minimize burning due to poor electrical connections.

(4) Do not strip an entire protective finish solely for magnetic particle inspection. If protective finish will be stripped because of flaking, peeling, or because of an established procedure, magnetic particle inspection shall follow stripping.

c. Magnetization.

(1) Magnetize each part with specified current density for 0.2 to 0.5 second for each charge. A longer time wastes current and increases danger of burning.

(a) Use controlled procedures in order to achieve a uniform magnetic flux of suitable density and direction in all parts.

(b) Amperage shall not vary more than ±20% from that specified.

(c) Adjust machine to obtain proper amperage.

(d) Make sure contacts are tight and clean.

(e) Do not release contact pressure until ammeter indicates zero.

(2) For circular magnetization, pass a high amperage, low voltage charge directly through part.

(a) On hollow parts, use a central conductor rod.

(b) On disk and ring-shaped parts, use the induced current method with suitably modified procedure, rather than a direct contact shot across the OD, to eliminate danger of contact burning.

(3) For longitudinal magnetization, place part in a solenoid carrying a direct current, interrupted by a fast break. Give a sufficient number of shots to cover the entire length of the part.

d. Immersion.

(1) Immerse magnetized part in agitated magnetic particle suspension of correct concentration for 0.5 to 2.0 minutes.

(2) Parts in baskets or trays shall not touch each other. Configuration of basket shall not interfere with circulation of fluid.

e. Inspection.

CAUTION

Eyeglasses with light-sensitive lenses shall not be used for fluorescent magnetic particle inspection. When exposed to ultraviolet (black) light, up to 50% loss in visual acuity may occur due to loss in light transmission through these lenses.

NOTE

Whenever the ID of a shaft or hole cannot be inspected by eye, use a mirror and light or a borescope.

(1) Visually inspect part after each immersion for magnetic particle indications. Use a suitable hooded booth or similar darkened area, and a black light with a minimum intensity of 1600 W/cm2.

(2) Identify imperfections and record necessary information. Final disposition of parts which have any discontinuities shall be made by experienced, designated personnel only.

(a) Mark or tag parts as necessary.

(b) Circle indications and questionable areas using an approved temporary marking method. (Refer to T.O. 2J-F100-53-1, WP 023 01.)

(c) Do not reject parts with irrelevant indications caused by minor surface pits and scratches which would be acceptable by visual inspection.

(3) If part showing questionable indications is passed for further service, a complete record showing location and extent of indications shall be maintained so that part will receive special attention at subsequent inspection. An indication may be recorded as follows:

(a) Apply a piece of transparent cellophane tape to indication.

(b) Carefully remove tape and apply to card, thus transferring the pattern from the specimen.

(c) Record applicable data on the card.

f. Demagnetization procedure.

NOTE

Hold part close to top or sides of demagnetizer.

(1) Pass part through entire length of demagnetizer.

(2) Withdraw part slowly. Rotate circular parts while withdrawing.

(3) Remove part straight away from demagnetizer. Do not turn off current until part is at least 3 feet from demagnetizer.

g. Demagnetization test - Field strength indicator method. (For alternate compass method, refer to paragraph 6.h.)

NOTE

- Perform test on at least first piece of each lot of parts, and not less than once during each 8 hour period.

- A suitable magnetic field strength indicator is the Model #25 Magnetometer available from R.B. Annis Company (1101 N. Deleware St,Indianapolis, IN 46202).

(1) Place suitable indicator in contact with part, with sides of meter adjacent to pivot end of pointer touching part.

(2) Move meter over all areas of part, particularly top and bottom rims of flanges and all projections from main body of part.

(3) Watch needle of indicator during this procedure. If part is properly demagnetized, the needle will not deflect more than two divisions from its point of rest.

(4) Repeat demagnetization of part if necessary. Refer to step f.

h. Demagnetization test - Compass method. (For alternate field strength indicator method, refer to paragraph 6.g.)

NOTE

- Perform test on at least first piece of each lot of parts, and not less than once during each 8 hour period.
- Use a good quality pocket compass with a needle approximately 1-1/2 inches in length, and a 1-3/4 to 1-7/8 inch case. Do not use a compass with an abnormal or sluggish needle.

(1) General method.

(a) Place compass on a wooden bench.

(b) Move part along its major axis in an east-west direction past north or south side of compass, keeping part in contact with compass case.

(c) If part is properly demagnetized, compass needle will not deflect end for end.

(2) For large or heavy parts.

(a) Place part on a wooden bench with its major axis in an east-west direction. This shall be done in an area where local magnetic field does not deflect compass more than 10 degrees.

(b) Move compass along north or south side of part, keeping compass in contact with part.

(c) If part is properly demagnetized, compass needle will not deflect end for end.

(3) For circular parts.

(a) place compass on a wooden bench.

(b) Hold part in contact with north or south side of compass, and rotate part 360 degrees.

(c) If part is properly demagnetized, compass needle will not deflect end for end.

(4) Repeat demagnetization of part, if necessary refer to step f.

i. Cleaning and preservation.

(1) Remove all magnetic substance from parts passing inspection and satisfactorily demagnetized.

(2) Coat all parts with MIL-L-7808 synthetic engine oil or with a corrosion preventive oil.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

INSPECTION, MAGNETIC PARTICLE (SPOP 101 THROUGH 118)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 16

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 16	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
General Engine and System Description - Basic Engine Features	WP 007 00
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Inspection, Magnetic Particle, General	WP 072 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cloth, crocus	P-C-458
Magnetic particle suspension, fluorescent	Magnaglo Powder No. 14AorTesting Systems Powder No. C-29F
Oil, corrosion preventive	MIL-C-15074
Paper, emery (No. 320 or fine)	-
Solvent, petroleum	P-D-680, Type II

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for magnetic particle inspection procedures. General instructions are provided in T.O. 2J-F100-53-1, WP 072 00.

2. LIST OF MAGNETIC PARTICLE INSPECTION METHODS.

a. Rod magnetization (SPOP 101).

b. Rod and solenoid magnetization (SPOP 102).

c. Rod and OD contact magnetization (SPOP 103).

d. End contact magnetization (SPOP 105).

e. End contact and solenoid magnetization (SPOP 106).

f. Solenoid magnetization (SPOP 107).

g. Shaft magnetic particle inspection (SPOP 108).

h. Disk magnetic particle inspection (SPOP 112).

i. Rod and induction (fixture or cable) magnetization (SPOP 115).

j. Induction (fixture or cable) and solenoid magnetization (SPOP 116).

k. Case magnetic particle inspection (SPOP 117).

l. Vane and shroud magnetic particle inspection (SPOP 118).

3. ROD MAGNETIZATION (SPOP 101).

a. See WP 072 00 for general instructions.

b. Vapor degrease per T.O. 2J-F100-53-1, SWP 031 01, if necessary.

c. Magnetize circularly, rotating eccentrically on insulated copper rod.

d. For gear with blind ID, install magnetizing rod in open end. Clamp rod and gear between heads of machine. No rotation of these parts is required.

e. Flow on or immerse in fluorescent magnetic particle suspension.

f. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

g. Inspect visually, record observations, and mark as required.

h. Demagnetize.

i. Wash with P-D-680, Type II, petroleum solvent.

j. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

4. ROD AND SOLENOID MAGNETIZATION (SPOP 102).

a. Refer to WP 072 00 for general instructions.

b. Vapor per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize circularly, rotating eccentrically on insulated copper rod, using first amperage number.

d. For gear with blind ID, install magnetizing rod in open end. Clamp rod and gear between heads of machine. No rotation these of parts is required.

e. Flow on or immerse in fluorescent magnetic particle suspension.

f. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

g. Inspect visually, record observations, and mark part as required.

h. Use solenoid with ID next larger than OD of part. Part longer than solenoid shall be given sufficient shots to cover entire length.

i. Magnetize longitudinally in solenoid, using second amperage number.

j. Flow on or immerse in fluorescent magnetic particle suspension.

k. If necessary, gently dip in P-D-680, Type II, petroleum solvent to remove excessive fluorescent background.

l. Inspect visually, record observations, and mark part as required.

m. Demagnetize.

n. Wash with P-D-680, Type II, petroleum solvent.

o. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

5. ROD AND OUTSIDE DIAMETER CONTACT MAGNETIZATION (SPOP 103).

a. Refer to WP 007 00 for general instructions.

b. Vapor degrease per SWP 031 01 if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize circularly, rotating eccentrically on insulated copper rod, using first amperage number.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Magnetize circularly by contacting on OD, using second amperage number.

h. Flow on or immerse in fluorescent magnetic particle suspension.

i. If necessary, gently dip in P-D-680, Type II, petroleum solvent to remove excessive fluorescent background.

j. Inspect visually, record observations, and mark part as required.

k. Demagnetize.

l. Wash with P-D-680, Type II petroleum solvent.

m. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

6. END CONTACT MAGNETIZATION (SPOP 105).

a. Refer to WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

c. Magnetize circularly, contacting on ends.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Demagnetize.

h. Wash with P-D-680, Type II petroleum solvent.

i. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

7. END CONTACT AND SOLENOID MAGNETIZATION (SPOP 106).

a. Refer to WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage numbers in order of appearance (for example, sequence no. first, second etc.) referenced below.

c. Magnetize circularly, contacting on ends, using first amperage number.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Use solenoid with ID next larger than OD of part. Part longer than solenoid shall be given sufficient shots to cover entire length.

h. Magnetize longitudinally in solenoid, using second amperage number.

i. Flow on or immerse in fluorescent magnetic particle suspension.

j. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

k. Inspect visually, record observations, and mark part as required.

l. Demagnetize.

m. Wash with P-D-680, Type II, petroleum solvent.

n. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

8. SOLENOID MAGNETIZATION (SPOP 107).

a. Refer to WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

c. Use solenoid with ID next larger than OD of part. Part longer than solenoid shall be given sufficient shots to cover entire length.

d. Magnetize longitudinally in solenoid.

e. Flow on or immerse in fluorescent magnetic particle suspension.

f. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

g. Inspect visually, record observations, and mark part as required.

h. Demagnetize.

i. Wash with P-D-680, Type II petroleum solvent.

j. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

9. SHAFT MAGNETIC PARTICLE INSPECTION (SPOP 108).

a. Refer to WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize longitudinally in 8 inch diameter solenoid, using first amperage number. Give sufficient number of shots to cover entire length.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Magnetize by induction. Use second amperage number and one of the following methods:

(1) Manual method.

(a) Insert the largest transformer soft iron core available that will pass through bore of shaft or ID of part.

(b) Wrap cable around flange OD three turns.

(c) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

(2) Fixture method.

(a) Center shaft on induced current portion of fixture.

(b) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

h. Flow on or immerse in fluorescent magnetic particle suspension.

i. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

j. Inspect visually, record observations, and mark part as required.

k. Demagnetize.

l. Magnetize shaft portion circularly by rotating eccentrically on insulated copper rod, using third amperage number.

m. Flow on or immerse in fluorescent magnetic particle suspension.

n. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

o. Inspect shaft portion visually, record observations, and mark as required.

p. Magnetize large OD portion circularly by rotating eccentrically on insulated copper rod, using fourth amperage number.

q. Flow on or immerse in fluorescent magnetic particle suspension.

r. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

s. Inspect large OD portion visually, record observations, and mark part as required.

t. Demagnetize.

u. Wash with P-D-680, Type II petroleum solvent.

v. Coat part with thin film of MIL-C-15074 corrosion preventive oil.

10. DISK MAGNETIC PARTICLE INSPECTION (SPOP 112).

a. See WP 072 00 for general instructions.

b. Degrease per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize circularly. Use first amperage number and one of the following methods:

(1) Manual method. Wrap 0000 cable through bore four turns. Give one shot of required amperage.

(2) Fixture method. Place disk on knife switch portion of fixture. Give one shot of required amperage.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Magnetize by induction. Use second amperage number and one of the following methods:

(1) Manual method.

(a) Insert the largest transformer soft iron core available that will pass through disk bore of ID of part.

(b) Wrap cable around disk OD three turns.

(c) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

(2) Fixture method.

(a) Center disk on induced current portion of fixture.

(b) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

h. Flow on or immerse in fluorescent magnetic particle suspension.

i. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

j. Pay special attention to blade contact areas. Use of a small mirror in each slot is recommended.

k. Inspect visually, record observations, and mark part as required.

l. Demagnetize.

m. Wash with P-D-680, Type II petroleum solvent.

n. Coat part with thin film of MIL-C-15074 corrosion preventive compound.

11. ROD AND INDUCTION (FIXTURE OR CABLE) MAGNETIZATION (SPOP 115).

a. Refer to WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize circularly, rotating eccentrically on insulated copper rod, using first amperage number.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Magnetize by induction. Use second amperage number and one of the following methods:

(1) Manual method.

(a) Insert the largest transformer soft iron core available that will pass through ID of part to be inspected.

(b) Wrap cable around OD of part three turns.

(c) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

(2) Fixture method.

(a) Center part on induced current fixture.

(b) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

h. Flow on or immerse in fluorescent magnetic particle suspension.

i. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

j. Inspect visually, record observations, and mark part as required.

k. Demagnetize.

l. Wash with P-D-680, Type II petroleum solvent.

m. Coat part with thin film of MIL-C-15074 corrosion preventive compound.

12. INDUCTION (FIXTURE OR CABLE) AND SOLENOID MAGNETIZATION (SPOP 116).

a. See WP 072 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize by induction. Use first amperage number and one of the following methods:

(1) Manual method.

(a) Insert the largest transformer soft iron core available that will pass through ID of part to be inspected.

(b) Wrap cable around OD of part three turns.

(c) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

(2) Fixture method.

(a) Center part on induced current fixture.

(b) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Use solenoid with ID next larger than OD of part. Part longer than solenoid shall be given sufficient shots to cover entire length.

h. Magnetize longitudinally in solenoid, using second amperage number.

i. Flow on or immerse in fluorescent magnetic particle suspension.

j. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

k. Inspect visually, record observations, and mark part as required.

l. Demagnetize.

m. Magnetize circularly by manual method, using third amperage number.

(1) Wrap cable through bore three turns.

(2) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in circuit.

n. Flow on or immerse in fluorescent magnetic particle suspension.

o. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

p. Inspect visually, record observations, and mark part as required.

q. Demagnetize.

r. Wash with P-D-680, Type II petroleum solvent.

s. Coat part with thin film of MIL-C-15074 corrosion preventive compound.

13. CASE MAGNETIC PARTICLE INSPECTION (SPOP 117).

a. Refer to WP 007 00 for general instructions.

b. Vapor degrease per SWP 031 01 if necessary.

c. For flow turned cases, omit steps d. through h. since these cases do not have an axial weld.

d. Magnetize circularly by applying 3500 amperes direct current (Continuous Method) through a single cable or insulated bar held to OD of case assembly adjacent to axial weld and extending 10 inches beyond front and rear flanges.

e. Apply fluorescent magnetic particle suspension to cover an area 10 inches maximum above and below cable or rod location as current is being applied.

f. If necessary, gently dip in P-D-680, Type II petroleum solvent or gently flow solvent over part to remove excessive fluorescent background.

g. Process ID equivalent area in similar manner to OD area of case assembly.

h. Inspect ID and OD of axial weld area using 100 watt ultraviolet (black) light and 3X magnification. Record observations and mark part as required.

i. Magnetize circularly by applying 3500 amperes direct current (Continuous Method) through a cable or rod placed along case adjacent to fuel drain bosses, and at four additional locations spaced approximately 60 degrees apart or 20 inches apart, so that entire case is circularly inspected.

j. Apply fluorescent magnetic particle suspension to cover an area 10 inches maximum above and below cable or rod location as current is being applied.

k. If necessary, gently dip in P-D-680, Type II petroleum solvent or gently flow solvent over part to remove excessive fluorescent backgroud.

l. Process ID equivalent area in similar manner to OD area of case assembly.

m. Inspect both ID and OD areas, particularly around fuel drain bosses, using 100 watt black light and 3X magnification. Record observations and mark part as required.

n. Magnetize case assembly longitudinally, using either Method I or Method II described below.

(1) Method I.

(a) Wrap cable around case two turns at rear flange and apply 2500 amperes direct current (Continuous Method).

(b) Apply fluorescent magnetic particle suspension to OD and ID of part.

(c) If necessary, gently dip in P-D-680, Type II petroleum solvent or gently flow solvent over part to remove excessive fluorescent background.

(d) Inspect entire area of rear third of case using a 100 watt black light. Use 3X magnification of axial and circumferential welds, and of the rear flange radius. Record observations and mark part as required.

(e) Move coil to center, and then to front flange of case, repeating magnetization and inspection procedure specified in steps (1)(a) through (1)(d) above to cover middle third and front third of case assembly.

(2) Method II (Alternate).

(a) Install case assembly rear flange down over laminated soft iron core of a Magnetizing Fixture (Induced Current), Model X-2152 manufactured by Magnaflux Corporation 7300 W. Lawrence Ave., Chicago, IL 60656, or equivalent. Position case off center in relation to core and rotate 360 degrees while applying 1000 amperes direct current (Continuous Method).

(b) Apply fluorescent magnetic particle suspension to OD and ID of part.

(c) If necessary, gently dip in P-D-680, Type II petroleum solvent or gently flow solvent over part to remove excessive fluorescent background.

(d) Inspect entire area of rear half of case. Use 3X magnification of axial and circumferential welds and of rear flange radius. Record observations and mark part as required.

(e) Invert case, and repeat magnetization and inspection procedures as in steps (2)(a) through (2)(d) above to cover front half of case.

o. Demagnetize by rotating case adjacent to largest available demagnetizer.

p. Wash with P-D-680, Type II petroleum solvent.

q. Coat part with thin film of MIL-C-15074 corrosion preventive compound.

14. VANE AND SHROUD MAGNETIC PARTICLE INSPECTION (SPOP 118).

a. See WP 007 00 for general instructions.

b. Vapor degrease per SWP 031 01, if necessary.

CAUTION

- Avoid contacting inner shroud seal.
- Where vanes are close together, one shot may include two or more vanes. Prevent burning by positive contact at both inner and outer shrouds.

NOTE

Required amperes are specified in applicable inspection WPs for each amperage number (first, second, etc) referenced below.

c. Magnetize circularly, contacting across each vane on inner and outer shrouds, using first amperage number.

d. Flow on or immerse in fluorescent magnetic particle suspension.

e. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

f. Inspect visually, record observations, and mark part as required.

g. Magnetize by induction. Use second amperage number and one of the following methods:

(1) Manual method.

(a) Wrap cable around OD of two mated vane and shroud halves three turns.

(b) Insert transformer core in center of assembly.

(c) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in the circuit.

(2) Fixture method.

(a) Center the two mated vane and shroud halves on induced current fixture.

(b) Magnetize with direct current for 0.2 to 0.5 second with Quick Break switch in the circuit.

h. Flow on or immerse in fluorescent magnetic particle suspension.

i. If necessary, gently dip in P-D-680, Type II petroleum solvent to remove excessive fluorescent background.

j. Inspect visually, record observations, and mark part as required.

k. Demagnetize.

l. Wash with P-D-680, Type II petroleum solvent.

m. Coat part with thin film of MIL-C-15074 corrosion preventive compound.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL INSPECTION PROCEDURES -

HARDNESS INSPECTION METHOD FOR ABRADABLE MATERIALS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 4

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1 - 4	14				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Pencil, silver	Eberhard Faber Colorbrite No. 2101
Marker, blue	Wallace Blue No. 600 or 700 or Dixon Redimark Blue No. 8500 or 8600

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

Paragraph	Function - Nomenclature	Tool Number
2	Rockwell superficial testing machine	King Indentec benchtop R10Z or equivalent
	Hardness penetrator (3/4 inch diameter ball)	NI-SP8
	HR10Z scale hardness blocks	USC-70

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for hardness inspection of abradable material on various engine parts.

2. HARDNESS INSPECTION METHOD FOR ABRADABLE MATERIALS

NOTE

- Prior to inspecting parts, an initial system check shall be performed by operator on each shift by taking at least five readings on calibrated hardness block. First reading shall be disregarded. If anvils, weights or penetrators have been replaced, take two or three readings to stabalize equipment.
- System verification check shall be performed a minimum of every 100 readings. System verification check shall be performed by taking one reading on hardness calibration block. If reading is within tolerance marked on hardness block, equipment is acceptable to use. If reading is outside tolerance, two additional readings shall be taken. If both readings are within tolerance, equipment is acceptable, otherwise, equipment shall not be used and all parts inspected since last system verification check shall be reinspected.
- Hardness block shall be within range of desired hardness when using ball penetrator. Impressions shall be made only on one side of hardness block. Impressions shall not be taken closer than 2.5 times diameter of impression to any edge or from each other.
- Inspection surface shall have smooth parallel surfaces perpendicular to indenture. Material shall not move or slip as the major load is being applied. Material support shall be sufficiently rigid to prevent permanent deformation during use. Anvil shall be large enough to leave no impression on back of test specimen. Outboard vertical support shall be used for hardness testing of long material which cannot be held firmly with minor load.
- Hardness tester shall be located in area free from vibration or mounted so that vibration is eliminated. Penetrators shall be free from dents, flats or other imperfections which might effect readings.
- Marking shall not be done on abradable material, use convenient edge of part.

a. Using authorized marker, assign and mark 12 locations equally spaced around circumference of part.

NOTE

When an individual reading is outside minimum or maximum hardness limits, that reading should be repeated at least 0.250 inch but not more than 1.000 inch on each side of suspect reading. Average of these two readings shall constitute individual hardness reading for that location.

b. Measure and record hardness readings on leading edge side of abradable at marked circumferential locations. Maintain 0.075 to 0.125 inch distance from centerline of abradable.

c. Measure and record hardness readings on trailing edge side of abradable at marked circumferential locations. Maintain 0.075 to 0.125 inch distance from centerline of abradable.

d. Record inspection results as follows:

(1) Hardness readings for each location.

(2) Averaged value of all individual readings (24 total).

(3) Individual maximum value.

(4) Individual minimum value.

WORK PACKAGE

INTRODUCTION

GENERAL REPAIR PROCEDURES

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	12				
2 - 5	0				
6	12				

1. INTRODUCTION.

a. This work package introduces the 090 00 and up series work packages for the Introduction and General Information manual. This series provides general repair information and repair methods work packages. The following work packages/ subordinate work packages are included in this series.

WP/SWP No.	Title
091 00	Grinding, Blending, Lapping, Buffing, and Peening
091 01	Buffing, Power Denicking of Titanium Parts (SPOP 532)
091 02	Buffing, Power Denicking of Steel, Nickel, and Cobalt Parts (SPOP 533)
091 03	Grinding, Machine, of Titanium Parts (SPOP 530)
091 04	Blending, Hole Radius (SPOP 502)
091 05	Lapping of Main Bearing Carbon Seals, Seal Plates, and Spacers
091 06	Optical Flatness Check of Main Bearing Carbon Seals, Seal Plates, and Spacers
091 07	Peening, Glass Bead (SPOP 500)
091 08	Peening, Steel Shot (SPOP 501)
091 09	Feature Control Symbols
092 00	Plating Procedures, General
092 01	Silver Plate, Bond Testing
092 02	Chromium Plate, Inspection
092 03	Nickel-Cadmium Plate, Test for Presence
092 04	Plating, Chromium, on Aluminum (SPOP 20)
092 05	Plating, Cadmium (SPOP 21)
092 06	Plating, Chromium, on Steel, Nickel, or Cobalt (SPOP 22)
092 07	Plating, Silver, on Steel (Not Stainless) (SPOP 23)
092 08	Plating, Silver, on Stainless Steel or Nickel (SPOP 24)

WP/SWP No.	Title
092 09	Plating, Nickel-Cadmium (SPOP 25)
092 10	Plating, Nickel, on Stainless Steel, Nickel, or Cobalt (SPOP 26)
092 11	Plating, Nickel, on Steel (Not Stainless) (SPOP 29)
092 12	Masking Procedures (SPOP 36)
092 13	Hard Coating, Aluminum (AMS 2468) (SPOP 39)
092 14	Stripping Nickel or Nickel-Cadmium Plate from Silver or Copper Alloy Brazed Parts (SPOP 40)
092 15	Chromate Conversion, Chemical, for Magnesium (SPOP 41)
092 16	Anodize Touch-Up, Brush or Swab (AMS 2473) (SPOP 42)
092 17	Plating, Barrel, Nickel-Cadmium (SPOP 49)
092 18	Stripping Plasma Spray Coatings with Nitric Acid (SPOP 50)
092 19	Stripping Plasma Spray Coatings with Caustic Soda (SPOP 51)
092 20	Stripping Plasma Spray Coatings with Nickel Strip Solution (SPOP 53)
092 21	Stripping PWA 47, PWA 73, or PWA 273 Aluminide Coating from PWA 655, PWA 656, PWA 663, PWA 1422, or PWA 1455 Parts with Nitric-Phosphoric Acid (SPOP 54)
092 22	Accelerated Stripping Nickel-Cadmium Plate from Martensitic Stainless Steel Compressor Blades with Acid (SPOP 56)
092 23	Cleaning Titanium with Acid (SPOP 302)
092 24	Stripping Plasma Coatings with Nitric-Sulfuric Acid (SPOP 304)
092 25	Stripping Silver or Copper Brazing Alloy from Corrosion and Heat Resistant Steel (SPOP 305)
092 26	Stripping PWA 77 Aluminide Coating (SPOP 307)
092 27	Stripping PWA 26, PWA 27, PWA 45, PWA 47, PWA 63, PWA 73, and PWA 273 Aluminide Coating from PWA 647, PWA 652, PWA 653, PWA 654, PWA 655, PWA 656, PWA 657, PWA 658, PWA 663, PWA 664, PWA 1038, PWA 1066, PWA 1422, PWA 1451, PWA 1455, or PWA 1456 Parts with Nitric Acid (SPOP 308)

WP/SWP No.	Title
098 03	Compound, Antigalling (PWA 550) Application (SPOP 156)
098 04	Compound, Antigalling (PWA 474), Application to Steel or Titanium Parts (SPOP 160)
098 05	Compound, Antigalling and Corrosion Preventive (PWA 559) Application (SPOP 161)
098 06	Compound, Loctite 40 Adhesive (PWA 549, TYPE II) Application (SPOP 163)
098 07	Compound, Antigalling (PWA 36545) Application (SPOP 748)
098 08	Compound, Sealant (PWA 552) Application
099 00	Composite Repair Procedures, General
100 00	Silicone Rubber (PWA 407) - General Storage, Preparation, and Application Instructions
101 00	Nondestructive Test For Rubber To Metal Bond Using PWA 52879 Checking Fixture
102 00 through 599 00	Open

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - GRINDING, BLENDING, LAPPING, BUFFING, AND PEENING

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Peening, Glass Bead (SPOP 500)	SWP 091 07
Peening, Steel Shot (SPOP 501)	SWP 091 08
Chromate Conversion, Chemical, for Magnesium (SPOP 41)	SWP 092 15
Anodize Touch-Up, Brush or Swab (SPOP 42)	SWP 092 16
Painting, Aluminized Epoxy Enamel (PWA 568, 569) (SPOP 148)	SWP 097 04

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general descriptions and instructions for depot maintenance grinding, blending, lapping, buffing, and peening.

2. GRINDING.

a. Data required for wheel grinding consists of the following:

(1) Type of abrasive.

(2) Grit size of abrasive.

(3) Type of wheel and bond.

(4) Wheel speed.

(5) Downfeed.

(6) Crossfeed.

(7) Table feed.

(8) Grinding fluid.

b. Data required for belt grinding consists of the following:

(1) Belt size.

(2) Type of abrasive.

(3) Grinding coolant.

(4) Belt speed.

(5) Work speed.

(6) Feed rate.

(7) Type of contact wheel.

(8) Type of motor.

c. Coarse abrasives shall be used for stock removal or to remove heavy lines on parts. To polish a surface to a finer finish, succeeding polishing steps shall be taken, using progressively finer abrasives until requirement is met. Each tool or grinding line shall be removed before the next finer abrasive is used.

3. BLENDING.

a. Blending is local removal of material in limited areas to repair and prevent propagation of nicks, scratches, or other surface damage.

b. Blending may be accomplished by using hand files or stones, or by carefully controlled use of power tools.

c. Blending may include grinding, filing, sanding, or buffing. Blending is sometimes controlled by dimensional limits, on parts which qualify to allow blending repair.

WARNING

Whenever magnesium parts are reworked, care shall be taken to remove dust, filings, turnings, and shavings as formed. Magnesium in these forms burns very rapidly, and under certain conditions when mixed with air, becomes explosive.

d. For magnesium parts, smooth over or remove burrs or scratches of a minor nature. Use fine files and fine grade abrasives. Clean up galling, slight scratches, or unevenness of mating or parting surfaces using crocus cloth and oil.

e. Unless otherwise specified, treat magnesium parts after rework, using T.O. 2J-F100-53-1, SWP 092 15 and 097 04 as required. Touch up blended areas with appropriate paint. Completely repaint if excessively flaked, chipped, or scratched.

f. Anodized aluminum parts may be touched up using T.O. 2J-F100-53-1, SWP 092 16.

g. For aluminum special fittings (air or oil), remove minor sealing surface damage such as nicks, burrs, or scratches, by hand working with a circular motion, using a No. 320 or fine emery paper.

CAUTION

Restrict hand working to fittings which mate with rubber seals.

h. Sealing surface damage to aluminum special fittings which cannot be removed by hand working may be refaced to original angle. Maximum of 0.010 inch of material thickness may be removed by machining.

i. For steel parts, clean up and blend burrs and minor galling, pitting, or scratches with crocus cloth and oil, or with fine stone. Be sure all bearing journals are smooth. A flat, fine stone is recommended when cleaning up gearteeth.

4. LAPPING.

a. Lapping is the ultimate step in surface finishing. Ordinarily it is the polishing method for preparing bearing and sealing surfaces, or parts requiring very close dimensional tolerances.

b. Lapping materials include levigated alumina, diamond dust or paste, jewelers rouge, and crocus cloth. Automated equipment is often used, to obtain standardized conditions for polishing, such as timing, rotational speed, and contact pressure.

c. Hand lapping is required for certain types of carbon seals and seal plates.

5. BUFFING.

a. Buffing is a relatively fine polishing operation in a refurbishing sequence, and is frequently preceded by power denicking, burring, blending, or sanding, depending on the type of rework, and condition of parts.

b. Buffing may be done with tampico or nylon brush impregnated with polishing compound, or with rubber-type wheels.

c. Buffing and denicking of titanium parts requires particular care to prevent burning. Belt-type sanding is not permitted, and the use of power tools is avoided, particularly on small or thin parts.

6. PEENING.

a. Peening may be either of two types: glass bead peening, or shotpeening with steel shot. A higher intensity can be obtained with steel shot than with glass beads.

b. Peening is primarily done to put a surface under compressive stress. This increases its resistance to metal fatigue, since the imparted stresses must be overcome before the metal can begin to weaken from applied strain.

c. Specific requirements for intensity and area to be peened will be provided in work packages/subordinate work packages along with the referenced procedure for a particular part. When no specific area is indicated for peening, part shall not be peened on all areas except small holes and cavities which are inaccessible to the shot.

d. No peening is permitted, unless specified by work packages/ subordinate work packages, on surfaces of keyways or holes other than lightening holes, which open into areas for which peening is required. Holes shall be suitably masked or plugged.

e. When shotpeening of gearteeth or splines is required, entire area of flank surfaces, top lands, and roots of teeth shall be peened to specified intensity. Ends of teeth shall be peened, but minimum peening intensity requirement shall be waived.

f. The expression, peening optional, shall mean that peening or intensity of peening on areas so indicated is optional, except that, if peened, areas shall have complete coverage with overlapping impressions.

g. Unless otherwise specified, variation in boundaries of areas to be peened, when limited, shall be minus 0.000 to plus 0.125 inch.

h. Intensity of peening is measured indirectly, by peening a test piece under similar conditions of geometry, distance, duration, and pressure. It is desirable to obtain conditions approximately midway between tolerance limits, so that a small rise or drop in shop air pressure will still allow continued peening within specified limits.

i. The instrument for measuring results on test pieces is the Almen gage. The designation Almen No. 2 is superfluous, since it is the only recognized gage.

j. There are three codes for test strips, according to their thicknesses: N, A, and C, respectively. Only the N and A are normally used in relation to aircraft engine parts. Both N and A strips are rectangular, approximately 3/4 x 3 inches, and composed of cold rolled spring steel. The N strip is used primarily for glass bead peening, and is 0.031 inch thick. The A strip is used primarily for shotpeening, and is 0.051 inch thick.

k. When the test strip is peened, it is given a very slight bow. It is this bow, or deviation from perfect flatness, which is measured on the Almen gage as arc height, in thousandths of an inch. An arc height of 0.012 inch on an A test strip is abbreviated 12A. An arc height of 0.006 inch on an N test strip is abbreviated 6N.

l. To make measurements on the Almen gage, test strip is located so that indicator pointer bears against the nonpeened surface. Arc height is read over a chordal length of 1.25 inches.

m. Glass bead peening per T.O. 2J-F100-53-1, SWP 091 07 and shotpeening per SWP 091 08 together satisfy the requirements of AMS 2430.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BUFFING, POWER DENICKING OF TITANIUM PARTS (SPOP 532)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Wheel, polishing	Carborundum No. C36-P-BFX2
Compound, precoat (PMC 3091)	Lea Ad-Lea-Sive
Compound, buffing, medium fine (PMC 3048)	Lea Grade E
Compound, buffing, polishing (PMC 3061)	Lea No. 2844

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance buffing and power denicking of titanium parts.

2. MECHANICAL FINISHING OF TITANIUM PARTS.

a. Mechanical finishing is defined as free hand polishing or deburring. It does not include grinding.

b. Silicon carbide or aluminum oxide abrasives are permissible for edge breaking and hole deburring; however, only silicon carbide abrasives shall be used for polishing the surface of titanium parts.

c. Silicon carbide abrasive wheels or rotary files shall always be used for weld preparation, excess weld removal, and weld repair.

CAUTION

If sparks are generated during finishing, ensure part and adjacent parts are shielded or masked as necessary to prevent spark impingement and burning.

d. Ensure overheating does not occur when polishing titanium parts. A light even pressure on the polishing wheel will give the best results, as it allows the abrasive to cut freely without loading up. Heavy pressure on polishing wheel may result in burning of metal, or produce the condition known as orange peel.

e. To polish a surface to a finer finish, succeeding polishing steps should be taken, using progressively finer abrasives until requirement is met.

3. POWER DENICKING AND BUFFING OF TITANIUM PARTS (SPOP 532)

WARNING

- Titanium parts shall not be repaired on equipment incorporating a water-wash dust collector that is used to clean steel and cobalt-base parts. Alloy dust mixtures could generate hydrogen gas, which is extremely flammable.
- An accumulation of titanium dust is a fire hazard. Do not allow titanium dust build up on clothing, and clean up titanium dust from machine and area at least once a day.

a. Denicking and buffing of titanium shall be done in strict accordance with these instructions to avoid burning parts. Do not use belt-type sanders. Because of difficulty in handling small parts and increased possibility of burning, titanium compressor blades with an airfoil length of less than 1-3/4 inches shall not be repaired using power tools.

b. Remove nicks, scratches or pits and form a radius on sharp edges of parts by blending on polishing lathe with small wheel such as Carborundum Co. No. C36-P-BFX2 or equivalent, using minimum wheel pressure. Do not operate at an arbor speed of more than 3600 rpm. Minimum radius of blend shall be four times blend depth.

CAUTION

Use only minimum pressure when applying part to the wheel to avoid overheating. Do not exceed 2400 rpm.

c. Blend out wheel marks, light nicks, scratches, and pits, and form a radius on sharp edges using wheel coated with precoat and medium fine buffing compounds. Buff repaired areas using 12-inch diameter tampico brush and buffing polishing compound at 2400 rpm maximum. Buff so that all polishing lines are parallel with the length of the airfoil, never across it. Maintain surface finish in the repaired area as nearly comparable to new part as possible.

d. Wipe part with soft, clean cloth to remove residual polishing compound and any foreign material.

e. Inspect repaired parts by applicable fluorescent penetrant inspection subordinate work package.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BUFFING, POWER DENICKING OF STEEL, NICKEL, AND COBALT PARTS (SPOP 533)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Sander, belt wheel, polishing	Carborundum No. A36-I-BFX2
Compound, precoat (PMC 3091)	Lea Ad-Lea-Sive
Compound, buffing, fine (PMC 3023)	Lea Grade A

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance buffing and power denicking of steel, nickel, and cobalt base parts (SPOP 533).

2. PROCEDURE.

WARNING

Steel and cobalt base parts shall not be repaired on equipment incorporating a water-wash dust collector that is used to repair titanium parts. Alloy dust mixtures could generate hydrogen gas, which is extremely flammable.

CAUTION

- At no time during repair of blades shall blades be permitted to heat beyond slight warmth as felt by hand. If overheating occurs, allow blades to air cool to room temperature before continuing repair.
- Do not belt sand compressor blades to repair damage. Repair all blade damage by local blending. A burr-cut rotary power file may be used to blend steel compressor blades.

a. Remove deep nicks, scratches, or pits and form a radius on sharp sharp edges of parts by blending on polishing lathe with small grinding wheel such as Carborundum Co. No. A36-I-BFX2, or equivalent. Do not operate wheel at an arbor speed of more than 3000 rpm. Minimum radius of blend shall be four times blend depth.

b. Blend out wheel marks, light nicks, scratches, and pits, and form a radius on sharp edges using polishing lathe wheel coated with precoat compound and fine buffing compound.

c. Belt sanders with 100 to 120 grit emery cloth may be used to remove abrasions from leading edge of turbine blades and restore leading edge radius. Belt sanders shall not be used to remove isolated abrasion.

d. Use only minimum pressure when applying part to wheel. Do not exceed 2400 rpm maximum.

e. All turbine blades which have been belt-sanded shall be polished to remove surface roughness.

f. Buff all reworked areas, and polish parts in such manner that all polishing lines are parallel with length of airfoil, never across it. Maintain surface finish in repaired area as nearly comparable to new part as possible.

g. Wipe parts with a soft, clean cloth to remove residual polishing compound and any foreign material.

h. Inspect repaired parts by applicable fluorescent penetrant or magnetic particle inspection subordinate work package.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - GRINDING, MACHINE, TITANIUM PARTS (SPOP 530)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

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1 - 7	0				
8 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Abrasive Aluminum Oxide (A1203)	Resinall Metalite 50XA 1203 (Thin Joint) or Fastcut Resin Cloth A50X (Thin Joint)
Abrasive Silicon Carbide	Resinall Durite 50X SiC (Thin Joint) or Fastcut Resin Cloth A50X (Thin Joint)
Coolant, Grinding, Nitrite Amine-type	Trim Ti-Grind or International No. 48
Coolant, Oil, Grinding (PMC 9259)	Vantrol 541-2M or Reilly-Whiteman X74-21 or Anderson 662 AntiMist
Wheel, grinding Aluminum Oxide (Al2O3)	Norton 32A60-L8VBE
Wheel, grinding silicon carbode (SIC)	Norton 37C80-L8V

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance machine grinding of titanium parts.

2. MACHINE GRINDING OF TITANIUM PARTS.

(See Table 1.)

Table 1. Wheel Spindle Speeds For Grinding Titanium Parts

Wheel Diameter Inches	Aluminum Oxide Maximum RPM	Silicon Carbide Maximum RPM
30	300	505
26	340	590
24	370	640
20	430	760
18	490	848
16	500	850
14	625	1090
12	725	1300
10	875	1500
8	1100	1900
7	1200	2200
6	1400	2400
5	1750	3000
4	2700	3800
3	2850	5000
2	4200	7600
1	8200	4000

NOTE

- The indicated speeds should be considered starting points only.
- Where it is not possible to change spindle speeds, diameter of wheel may be reduced to concur with maximum SFPM.

WARNING

- Remove grinding sludge from machine at frequent intervals to avoid possibility of generating hydrogen gas. Hydrogen gas is highly flammable or explosive.
- Clean up titanium dust from machine and area at least once a day. Do not allow titanium dust to accumulate on clothing. An accumulation of titanium dust is a fire hazard.

NOTE

The term grinding, as used in this SPOP, shall apply only to operations where the tool and workpiece are both mechanically fixtured.

a. Data for grinding titanium parts, using aluminum oxide (A1203) grinding wheels:

	ROUGHING	FINISHING
Abrasive size	36 to 120	36 to 120
Wheel hardness	Medium (I to M)	Medium (I to M)
BondTypical wheel:	Vitrified 32A60-L8VBE (Norton Company)	Vitrified
Wheel speed, Surface feet per minute (SFPM) (See table 1)	2300 Maximum	2300 Maximum
Downfeed, inch per pass	0.001 Maximum	0.0005 Maximum
Crossfeed, inch per pass	0.025 to 0.050	0.025 to 0.050
Table speed, Feet per minute (FPM)	30 to 150	30 to 150
Grinding coolant	Grinding coolant, Nitrite Amine-type Diluted One Part with 30 Parts Water by Volume	Grinding coolant, Nitrite Amine-type Diluted One Part with 30 Parts Water by Volume

b. Data for grinding titanium parts, using silicon carbide (SiC) grinding wheels:

	ROUGHING	FINISHING
Abrasive size	54 to 120	54 to 120
BondTypical wheel:	Vitrified 37C80-L8V (Norton Company)	Vitrified
Wheel speed, SFPM	4000 Maximum	4000 Maximum
Downfeed, inch per pass	0.001 Maximum	0.0005 Maximum
Crossfeed, inch per pass	0.025 Maximum	0.025 Maximum
Table speed, FPM	30 to 150	30 to 150
Grinding coolant	Grinding Oil	Grinding Oil

c. Data for belt grinding titanium parts:

Belt Size:	1 inch x 90 inches (typical)
Abrasive:	A1203 - Resinall Metalite 50XA1203 (Thin Joint) (Norton Company)
	- Fastcut Resin Cloth A50X (Thin Joint) (Carborundum Company)
	SiC - Resinall Durite 50XSiC (Thin Joint) (Norton Company)
	- Fastcut Resin Cloth C50X (Thin Joint) (Carborundum Company)
Grinding Coolant:	Grinding Oil
Belt Speed, SFPM	1000 to 1200
Work Speed, SFPM	27.5
Feed:	0.125 inch per 1 revolution of work - remove 0.003 to 0.004 inch from OD.
Contact Wheel:	Steel, with 0.002 inch crown
Motor:	3 horsepower

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

BLENDING, HOLE RADIUS (SPOP 502)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 11	0				
12 Blank	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cloth, abrasive, 120 grit, 1.5 inches wide	Bear Handy Roll Lightening Metalite Cloth, or equivalent
Tape, metal foil	Scotch No. 428B pressure-sensitive aluminum foil masking tape, or equivalent

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance hole radius blending.

2. PURPOSE OF PROCEDURE.

a. Increase operational life of disks, shafts, rotor spacers, and hubs.

b. Improve surface finish and contour of tiebolt, counterweight, and lightening holes.

c. Eliminate sharp corners or edges at ends of holes which were made oversize; then restore to required dimensions by plating and machining.

d. Restore radius at ends of holes after machining the face of a part.

e. Make uniform radius at ends of holes after plating and removal of excess plate.

3. EQUIPMENT.

(See Figures 1, 2, and 3.)

a. Obtain or fabricate the following tools.

(1) Steel spindle per figure 1.

NOTE

If drill press method is used, stop or backup plate on holding fixture is not required.

(2) Holding fixture is required, similar to arrangement shown in figures 2 and 3.

(3) Steel masks to protect snap diameters and faces of disks as shown in figure 2. Make mask of 0.015 to 0.030 inch thick stainless steel, or of low alloy steel with a chromium flash for abrasion resistance. Holes in masks above holes being blended shall be approximately 0.25 inch diameter larger than holes of part. Height of lip protecting snap diameter shall not interfere with action of abrasive so as to cause blend to be off center, or leave area at end of hole which has not been reworked.

(4) Abrasive cloth strip, No. 120 grit aluminum oxide, 1.5 inches in width. Stiffness and cutting quality of abrasive cloth will affect contour or radius of reworked holes, and amount and rate of material removal.

(5) Power tool capable of 18,000 rpm, unloaded. Tools among those meeting this requirement are the Cleco* Air Gun, Model GLF-180, and the DuMore**, Model 8-011.

*Obtainable from Cleco Air Tools, Box 2541, Houston TX 77001.

**Obtainable from DuMore Co., 1300 17th St., Racine, WI 53403.

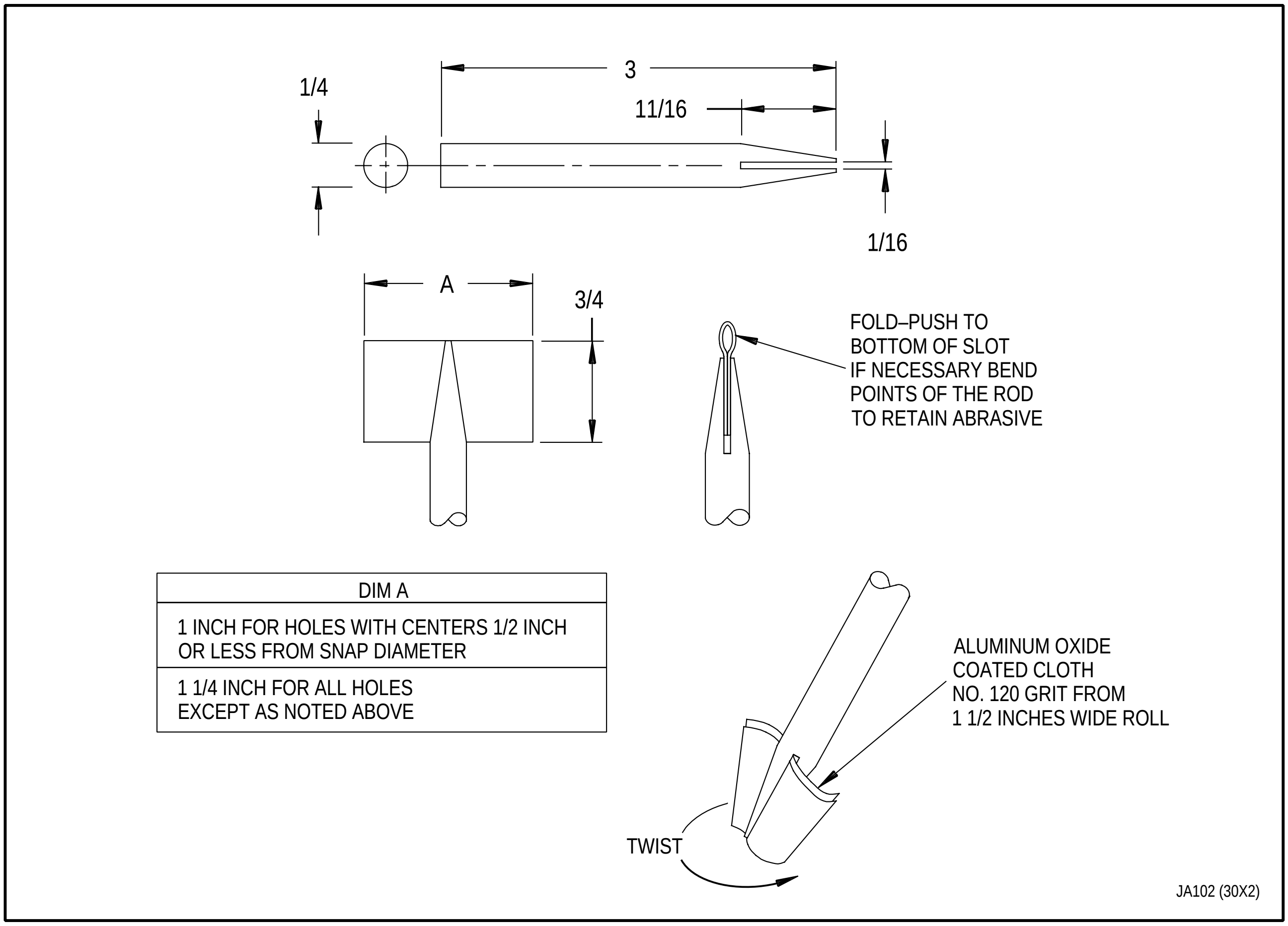


Figure 1. Spindle and Abrasive Cloth (Butterfly) for Hole Radius Rework

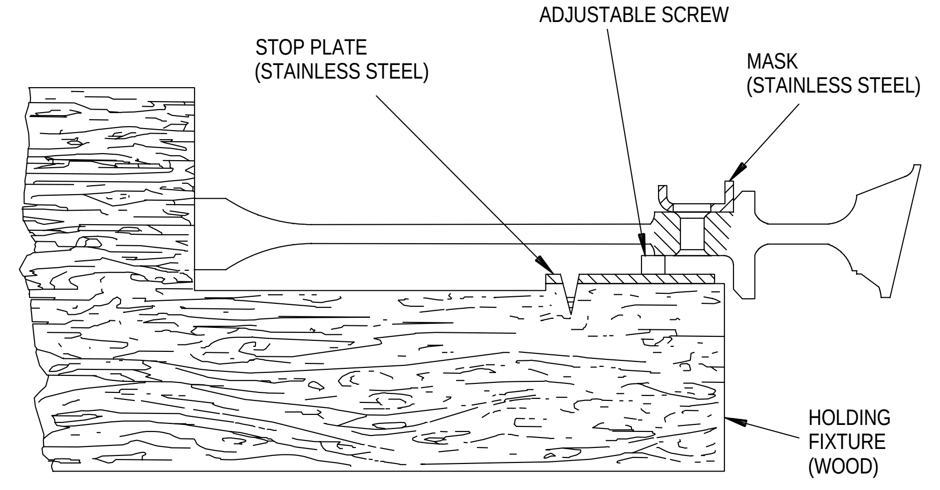


Figure 2. Typical Stop Plate Setup and Holding Fixture for Compressor Disk Rework

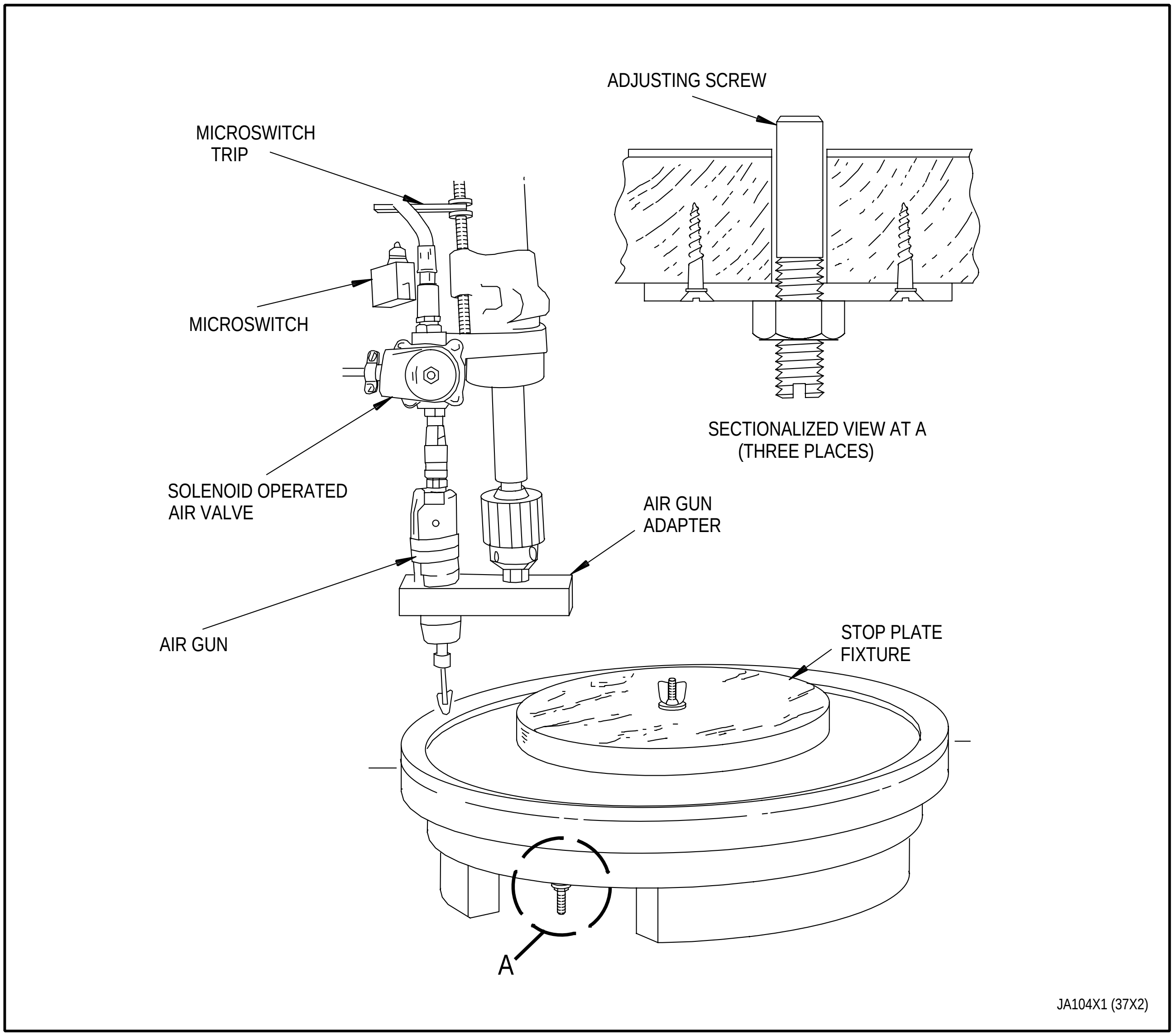


Figure 3. Semiautomatic Tool Setup

4. PROCEDURE.

(See figure 3 and Figures 4 through 7.)

a. Fixture part using manual or semiautomatic setup suggested in paragraph 3, or a similar arrangement which accomplishes the requirements of this procedure.

b. Secure air gun to spindle of drill press using appropriate adapter. (See figure 3.)

c. Install spindle in chuck of air gun.

d. Mount disk or hub on holding fixture.

e. Install mask on face of disk or hub and secure in place with masking tape or soft jaw (nonmetallic) clamps. Protect vertical surfaces of adjacent areas if necessary using metal foil tape.

f. Adjust drill press stop or suitable stop plate, so abrasive holding spindle will penetrate hole to depth specified by graph. (See figure 4.)

g. Cut abrasive cloth to 1 or 1 1/4 ±1/16 inch as appropriate per figure 1. Fold in half along the 1 1/2 inch dimension (width of roll as purchased), so that a 3/4 ±1/16 inch strip has the abrasive surface outermost on both sides. Insert in spindle open edges first, and push to bottom of slot. Twist firmly in direction indicated (opposite that of spindle rotation). Points of spindle may be bent together slightly to improve retention of abrasive cloth.

NOTE

Automatic timers and limit switches may be used to stop and start air gun if desired.

h. Start air gun and lower spindle into hole to required depth of penetration. Raise and lower rotating spindle in reciprocating stroke of approximately 1/16 inch, twice a second. Approximately 6 to 12 seconds is typical time required to produce a blended radius for each hole.

NOTE

1. DEPTH SETTINGS SHOULD BE TO THE NEAREST 1/64 INCH
2. THIS GRAPH IS NOT APPLICABLE TO COUNTERBORED HOLES

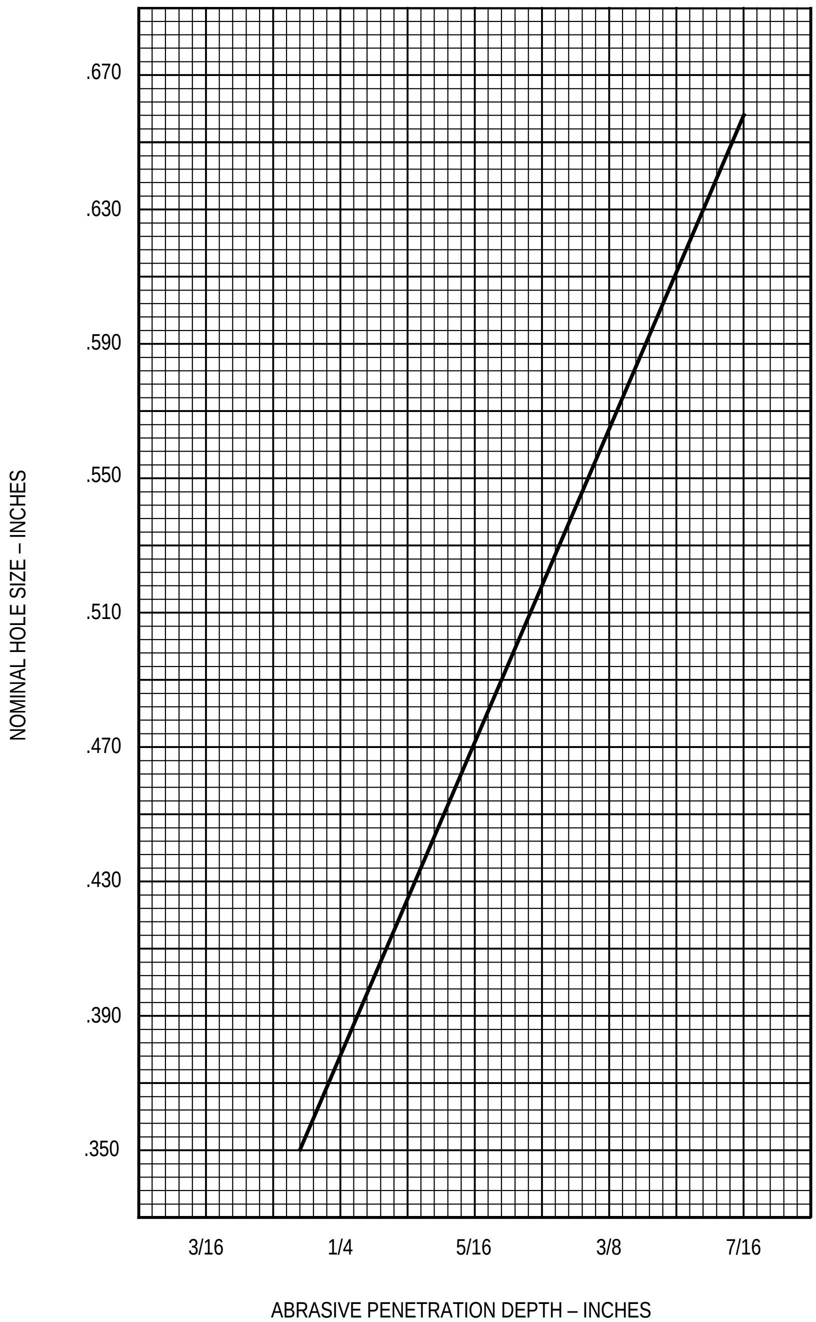


Figure 4. Abrasive Penetration Depth

i. Inspect radius area for desired contour blending into adjacent surfaces with no sharp ridges, edges, or indentations.

(1) Contour of intersection of holes with face of part shall form a smoothly faired radius, or in the case of a hole having a machined chamfer, shall form a blended radius at each angle as shown in figure 5.

(2) Chatter marks or tool marks are not acceptable.

(3) All roughness surface finish requirements apply to blended areas as appropriate.

(4) Circular scratches on bolting face caused by butterfly polishing are acceptable provided each scratch depth does not exceed that of normal machining feed lines.

(5) Refer to T.O. 2-1-111, Standard Maintenance Procedures, Chapter 11, for a photograph illustrating acceptable and rejectable conditions of butterfly finished holes.

j. Continue blending operation if required.

k. Make one final pass, inserting and withdrawing spindle through a period of five seconds.

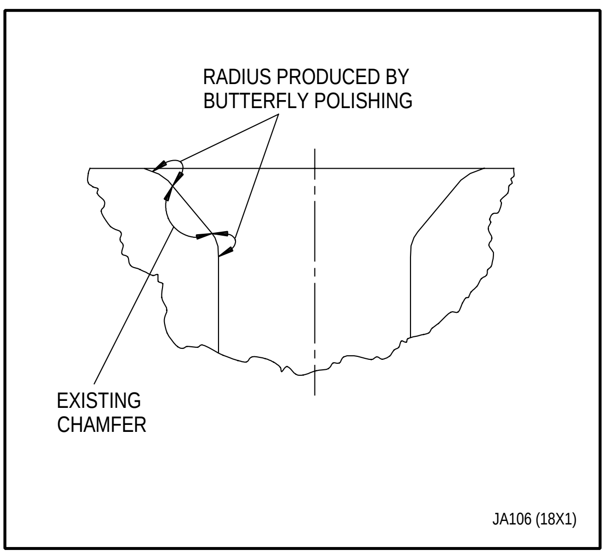


Figure 5. Hole Radius Blend Contour

l. Inspect reworked area per step i., and using an appropriate plug gage as illustrated in figure 6, check maximum diameter of rework on face of part. See figure 8 for limits. Reworked area shall not be visible beyond edge of plug gage, and there shall be no radial scratches or indentations.

m. Repeat this procedure (paragraph 4) for each end of each hole, using a new piece of abrasive cloth for each operation.

n. See figure 7 for values for Diameter X and Diameter Y.

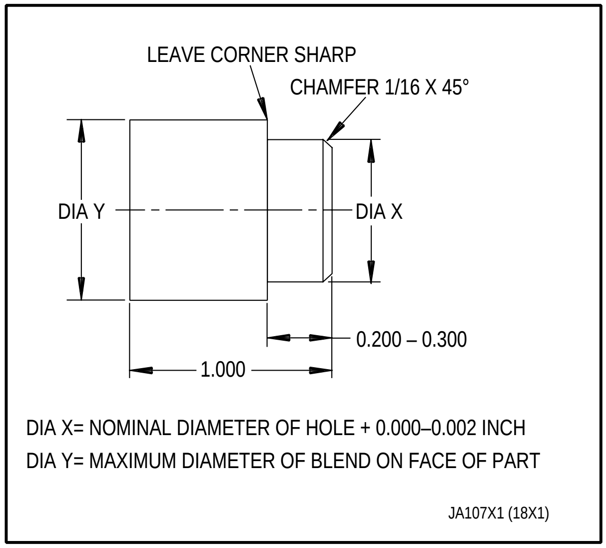


Figure 6. Typical Plug Gage

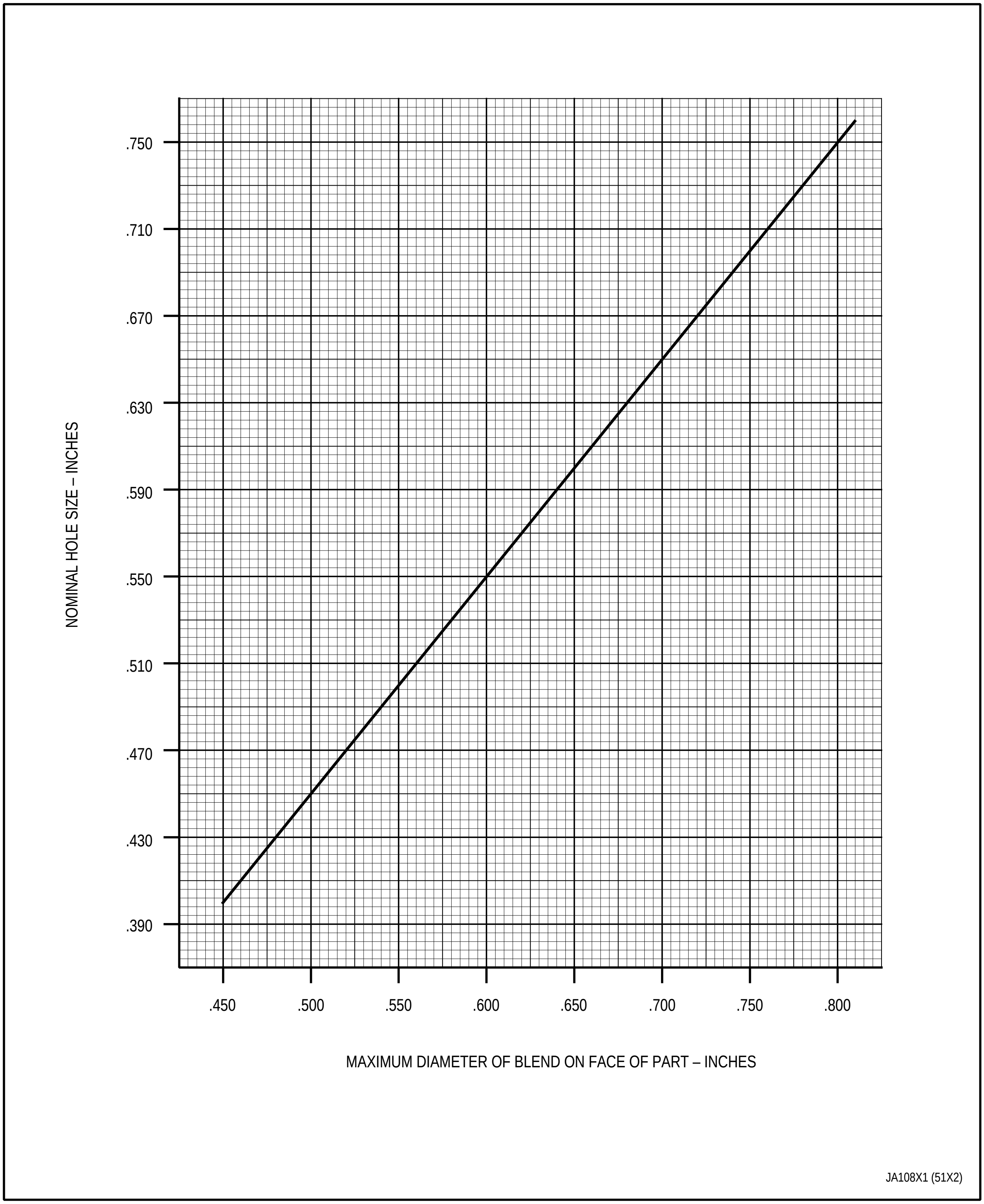


Figure 7. Maximum Diameter of Blend on Face of Part

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - LAPPING OF MAIN BEARING CARBON SEALS, SEAL PLATES, AND SPACERS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Optical Flatness Check of Main Bearing Carbon Seals, Seal Plates, and Spacers -	SWP 091 06

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cleaner, ultrasonic	Turco 4181 or Bendix 25-I
Compound, lapping, corundum	Crane Packing Co. No. 1800 or Mosher Co. No. 125, or equivalent
Compound, lapping, diamond	Elgin No. 3
Compound, metal cutting	Fanox N-33
Solvent, petroleum	P-D-680, Type II

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance lapping of main bearing carbon seals, seal plates, and spacers.

2. PROCEDURE.

CAUTION

- Do not use abrasive compounds to lap or polish carbon element seal face. Abrasive particles can become embedded in carbon material which will cause wear damage to seal seat during engine operation.
- Lap seal seats by machine only. Hand lapping can cause deterioration of seal hardface coating.

NOTE

One helium light band (center of dark area to center of adjacent dark area) is equivalent to 11.6 millionths of an inch.

a. Maintain all lapping equipment per manufacturer’s instructions. Check flatness of lap surface frequently. Resurface as necessary to achieve satisfactory optical flatness check.

b. This procedure shall produce a flatness of each carbon seal, seal plate, or spacer within two helium light bands unless otherwise specified in work packages/subordinate work packages. Refer to T.O. 2J-F100-53-1, SWP 091 06 for optical flatness check.

c. Lap each carbon seal on a series of polished marble plates, or equivalent, covered with lapping papers beginning with No. 400 or finer. Hold part to be lapped with a suitable fixture padded with sponge rubber, or an equivalent method of securing part. Use a sliding, circular motion, and distribute pressure evenly. Proceed through degrees of fineness of papers used.

d. Lapping procedures shall obtain the following conditions:

(1) Required surface condition.

(2) Required flatness.

(3) No abrasive embedded in lapped surface.

e. Machine lapping of uncoated and chromium plated areas.

NOTE

Time required to lap original parts will be less than time required to lap parts repaired by chromium plating.

(1) Use a Lapmaster machine, manufactured by the Crane Packing Co, 6400 West Oakton Street, Morton Grove, IL 60053, or equivalent.

(2) Use a mixture of four ounces of a fine grit lapping compound such as Crane Packing Co No. 1800 or Mosher Co No. 125, to 1 gallon of lapping vehicle such as metal cutting compound Fanox N-33, or equivalent.

f. Machine lapping of surfaces requiring diamond lapping, such as Linde Flame Plate areas.

(1) Use basic lapping equipment manufactured by the Crane Packing Co, The Norton Co, Taft-Peirce Mfg Co, or equivalent. Machine shall be capable of producing required surface finishes and be specifically suited for the use of diamond lapping compounds.

(2) Use a gray cast iron or Meehanite GA lap plate. The lap surface shall contain serrations or grooves forming a square pattern. Grooves shall be 1/32 to 1/16 inch wide by 1/32 to 1/16 inch deep, located approximately 1/2 inch apart. A relief at least 1/4 as large as the outside diameter of the lap plate shall be provided in the lap center.

CAUTION

Use diamond paste in a controlled area. Prevent other engine components from coming into contact with diamond paste.

(3) The diamond lapping compound shall be thoroughly embedded in the lap. Drive or force a standard No. 3 diamond lapping compound, or equivalent, into lap by lapping with a hardened steel or Linde Flame Plate disk which has been weighted to approximately 20 psi. The disk shall be placed in the conditioning rings in same manner as a part to be lapped.

(4) Apply a thin film of P-D-680, Type II petroleum solvent to lap. Run lap fairly dry until its surface takes on an iridescent appearance. Lap shall appear dull as opposed to a wet look it too much solvent had been used. Lap surface shall be very dark when fully charged.

(5) Lap part using 1 to 20 psi and 100 to 300 surface feet per minute, as measured at the mean diameter of lapping area.

(6) Recharging lap is required only when lapping time is increased beyond 50% of time recorded when lap is fully charged. If part is loaded to 20 psi, finish requirement will be obtained in approximately 25 minutes provided all operating conditions are satisfied.

(7) Check lapped surface per T.O. 2J-F100-53-1, SWP 091 06.

CAUTION

Do not use an acid-containing cleaner.

NOTE

If parts are to be stored temporarily before cleaning, keep wet with P-D-680, Type II petroleum solvent to prevent caking of lapping compound.

(8) Clean parts in an ultrasonic cleaning machine, using an alkaline cleaner such as Turco 4181, Bendix 25-I, or equivalent.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - OPTICAL FLATNESS CHECK OF MAIN BEARING CARBON SEALS, SEAL PLATES, AND SPACERS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Measuring Tools -	T.O. 32-1-201

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cloth, polishing	Norton 4/0
Compound, diamond	No. 9

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance optical flatness checking of main bearing carbon seals, seal plates, and spacers.

2. PROCEDURE.

NOTE

- This check is waived if a satisfactory air pressure check can be performed. Used or repaired carbon seals, seal plates, or spacers which will pass an air pressure check with dummy sealing surfaces are considered serviceable without an additional optical flatness check.
- One helium light band (center of dark area to center of adjacent dark area) is equivalent to 11.6 millionths of an inch.

a. Inspect optical flats periodically. Replace if scratched or damaged such that satisfactory results cannot be obtained.

b. Check flatness of carbon seal, seal plate, or spacer with an optical flat and monochromatic light. Flatness is measured in helium light bands.

c. T.O. 32-1-201 may be used for specific operation instructions.

CAUTION

- No. 9 diamond compound can be used on seal seats only. Do not use abrasive compounds on carbon face seals.
- Tightly stretch polishing cloth over a flat surface to prevent rounding or curling of edges, and to eliminate unevenness.

d. To facilitate this check, polish each part with No. 9 diamond compound or by lightly rubbing on Norton 4/0 (0.0000) polishing cloth, or equivalent, mounted on a flat plate.

e. Optical flat may either rest on surface being inspected without external support, or part may be pressed down to assure contact between optical flat and surface being inspected. Unless other wise specified, load imposed on part shall be evenly distributed and shall not exceed four pounds per inch of part diameter.

f. Unless otherwise specified for a particular part in WP/SWP, flatness of each carbon seal, seal plate, or spacer shall be within two helium light bands.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PEENING, GLASS BEAD (SPOP 500)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Grinding, Blending, Lapping, Buffing and Peening	WP 091 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, antisolidifying	Anaset or No-Pac
Corrosion inhibitor, water conditioning	X61-60
Glass beads, Size 5 or 6	MIL-G-9954
Oil, Corrosion preventive	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance glass bead peening.

2. PROCEDURE.

NOTE

This procedure, together with shotpeening per SWP 091 08, satisfies the requirements of AMS 2430. A portion of AMS 2430 no longer pertains to the type of equipment in general Depot use, so procedure has been suitably modified.

a. Check condition of equipment, including condition and correct size of nozzle (3/8 inch diameter), air jet (1/4 inch diameter), and check hoses for wear.

NOTE

Cabinets may be obtained from Vacu-Blast Corp, Belmont, CA 94002, Zero Blast Co, Washington, MO 63090, or The Metal Improvement Co, Peenamatic Division, Carlstadt, NJ 07072.

b. If peening is by dry glass beads, beads shall be used only once, unless cabinet is equipped with separator for broken beads.

c. If peening is by dry glass beads in cabinet equipped with separator, or by wet glass beads (slurry), the first part peened with new beads shall be retained as a visual standard. If any subsequently peened part has dull matte finish rather than the typical shiny peened surface as on the retained part, glass bead charge is excessively broken and shall be replaced.

NOTE

MIL-G-9954, Size 5 glass beads may be substituted when peening parts unless they contain fillets having radii less than 0.040 inch.

d. Fill machine with dry MIL-G-9954, Size 6 glass beads, or with a slurry prepared as follows:

Materials	Make-up
MIL-G-9954, Size 6	5 to 8 pounds per gallon of water glass beads
Compound, antisolidifying	4 ounces per 50 pounds of beads
Corrosion inhibitor	15 ml per gallon of water

(1) Fill tank with water to 75% of total operating volume.

(2) With pump operating, slowly add required amount of glass beads.

(3) Add required amounts of antisolidifying compound and corrosion inhibitor.

(4) Fill tank to 100% of operating volume. Allow slurry to mix freely for 2 to 3 minutes before use.

(5) Maintaining slurry.

(a) Check abrasive content every four hours.

(b) Collect a 500 ml sample in a graduated cylinder as slurry leaves gun. If suction-type cabinet is being used, take sample from hopper.

(c) Maintain abrasive content at 30 to 40% by volume.

(d) Add 3 ml corrosion inhibitor for each pound of abrasive added. Add 1/2 ounce antisolidifying compound for every 6 pounds of abrasive added.

NOTE

- Specifications for test strips, holding block, and Almen gage are contained in SAE Standard J442 in the SAE Handbook (Society of Automotive Engineers).
- Almen N test strips may be procured, among others, from the following sources:
  - Associated Spring Corp.
    Wallace Barnes Div.
    18 Main St.
    Bristol, CT 06010
  - Connecticut Spring Corp.
    5 Spring Lane
    Farmington, CT 06032
- Almen gage may be procured from:
  - Wheelabrator-Frye, Inc.
    Mishawaka, IN 46544

e. Set up test block and N strip in cabinet so position of strip in relation to nozzle(s) will be exactly the same as position of part to be peened. This may vary if parts cannot be peened at a 90 degree angle.

f. When peening test strip, put it through the same rotational or translational movement that the part will make in relation to the nozzle(s).

g. Peening requirement is specified in arc height. Arc height is the result obtained on an Almen gage by measuring a test strip after peening.

h. The range (or tolerance) is usually expressed in the required arc height.

Example: 12 to 15N or 12N +3/-0 refers to an arc height of 0.012 to 0.015 inch on the N test strip.

i. If requirement is given without a range, then a standard tolerance of minus 0 to plus 30% (or minimum of 0.003 inch) applies.

Examples:

20N = 0.020 - 0.026 inch = 20 to 26N

10N = 0.010 to 0.013 inch = 10 - 13N

5N = 0.005 - 0.008 inch = 5 - 8N

j. Expose rotating test strip to nozzle for entire duration of blasting. If more than one nozzle is used for coverage, all nozzles shall be turned on for this test and a test strip used for each nozzle. All portions of one side of each test strip shall be completely dimpled.

NOTE

In no case shall a peened specimen, after removal from the holding device, be reinstalled for additional peening.

k. To achieve specified arc height, the following conditions shall be established by peening N-test strip(s), attached to suitable block(s) or fixture(s):

- Air pressure
- Rotating wheel speed, if applicable
- Translational speed, as applicable
- Orientation of nozzle(s)
- Distance from nozzle(s) to surface being peened
- Duration of exposure to peening medium

l. Duration of exposure shall be selected such that doubling time produces no more than a 10% increase in arc height on test strip.

m. If it is necessary to make a significant change in air pressure, install new test strip and repeat test at new pressure.

n. Following peening, remove test strip from cabinet and measure on Almen gage. Test strip(s) shall show uniform and complete coverage as well as required arc height.

o. A minimum of one test strip shall be run every two hours of operation as well as at beginning of any work shift or start for peening a series of any particular part.

p. Ensure that parts have been processed through depot maintenance cleaning prior to peening. When necessary, mask areas of part not to be peened using mechanical masks, or sufficient layers of plastic masking tape, or equivalent.

q. If a boundary is specified for peening area, but no tolerance given, peening shall be complete within boundary, and may extend up to 0.125 inch outside boundary.

NOTE

If very few parts are to be peened and it is desired to do them without fixturing, it is permissible to peen with hand-held nozzle; however, consistent results are difficult to maintain.

r. Mount part on rotating table so that area to be peened is in exactly same position which test block occupied. When area to be peened is larger than nozzle spray pattern, set up additional fixed nozzles with overlapping spray to fully cover area to be peened.

s. Blast surface of part to be peened, using same conditions established with test strip(s) for obtaining required arc height, listed in step h.

t. Remove masking, if used. Clean residue from part.

u. Rinse in hot water, 150° to 200°F (66° to 93°C). In tanks used to rinse parts susceptible to rusting, condition water with one part corrosion inhibitor to 150 parts water.

v. Dry with air blast.

w. Inspect visually for uniformity of peening and complete coverage. Holes and edges of part shall be free from rolled metal and glass bead residue.

x. Preserve as required using MIL-C-15074 corrosion preventive oil.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PEENING, STEEL SHOT (SPOP 501)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Grinding, Blending, Lapping, Buffing, and Peening	WP 091 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, Corrosion preventive	MIL-C-15074
Shot, Steel, Cast, S110 or S170	MIL-S-13165

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance shotpeening.

2. SIEVE TESTING.

(See Table 1.)

NOTE

- Sieve analysis shall be done weekly on steel shot in use.
- Acceptable steel shot shall be composed predominantly of spherical particles, since irregular shot is less durable.

a. Obtain a representative 100 gram sample, preferably from cabinet nozzle.

b. Place sample on stacked sieve set, with screens selected per table 1.

Table 1. Sieve Analysis For Steel Shot

SAE S110		SAE S170		SAE S230	
Retained By Screen	Percent By Weight	Retained By Screen	Percent By Weight	Retained By Screen	Percent By Weight
#30	0 max	#20	0 max	#18	0 max
35	10 max	25	10 max	20	10 max
50	80 min	40	85 min	30	85 min
80	90 min	45	97 min	35	97 min

NOTE

- Value given for fraction retained by each screen includes all coarser screens.
- SAE S170 cast shot may be substituted for SAE S110 case shot only when specifically directed in work packages/subordinate work packages.
- SAE S230 cast shot is not an authorized alternative, but sieve analysis is given for comparison and convenience of reference.

c. Shake for 10 minutes, plus or minus 5 seconds, in a rotating and tapping testing apparatus, having a shaking speed of 275 to 295 rpm and a tapping rate of 145 to 160 taps per minute.

d. Weigh fractions retained on each screen. Percentages shall conform to requirements listed in table 1.

3. PROCEDURE.

NOTE

This procedure, together with Glass Bead Peening per SWP 091 07, satisfies the requirements of AMS 2430. A portion of AMS 2430 no longer pertains to the type of equipment in general Depot use, so procedure has been suitably modified.

a. Check condition of equipment, including condition and correct size of nozzle and air jet; check hoses for wear.

b. Fill machine with required amount of SAE S110 cast shot.

NOTE

- Specifications for test strips, holding block, and Almen gage are contained in SAE Standard J442 in the SAE Handbook (Society of Automotive Engineers).
- Almen A test strips may be procured, among others, from the Associated Spring Corp., BGR Division, Plymouth, MI 48170.
- Almen gage may be procured from Wheelabrator-Frye, Inc., Mishawaka, IN 46544.

c. Set up test block and A strip in cabinet so position of strip in relation to nozzle(s) will be exactly the same as position of part to be peened. This may vary if parts cannot be peened at a 90 degree angle.

d. When peening test strip, put it through the same rotational or translational movement that the part will make in relation to the nozzle(s).

e. Peening requirement is specified in arc height. Arc height is the result obtained on an Almen gage by measuring a test strip after peening.

f. The range (or tolerance) is usually expressed in the required arc height.

Example: 12 to 15A or 12A + 3/–0 refers to an arc height of 0.012 to 0.015 inch on the A test strip.

g. If requirement is given without a range, then a standard tolerance of -0 to +30% (or minimum of 0.003 inch) applies.

Examples:

20A	=	0.020 to 0.026 inch	=	20 to 26A
10A	=	0.010 to 0.013 inch	=	10 to 13A
5A	=	0.005 to 0.008 inch	=	5 to 8A

NOTE

- If more than one nozzle is used for coverage, all nozzles shall be turned on for this test and a test strip used for each nozzle. All portions of one side of each test strip shall be completely dimpled.
- In no case shall a peened specimen, after removal from the holding device, be reinstalled for additional peening.

h. Expose rotating test strip to nozzle for duration of blasting.

i. To achieve specified arc height, the following conditions shall be established by peening A-test strip(s), attached to suitable block(s) or fixture(s):

- Air pressure
- Rotating wheel speed, if applicable
- Translational speed, as applicable
- Orientation of nozzle(s)
- Distance from nozzle(s) to surface being peened
- Duration of exposure to peening shot

j. Duration of exposure shall be selected such that doubling time produces no more than a 10% increase in arc height on test strip.

k. If it is necessary to make a significant change in air pressure, install new test strip and repeat test at new pressure.

l. Following peening, remove test strip from cabinet and measure on Almen gage. Test strip(s) shall show uniform and complete coverage as well as required arc height.

m. A minimum of one test strip shall be run every four hours of operation as well as at beginning of any work shift or start for peening a series of any particular part.

n. Ensure that parts have been processed through depot maintenance cleaning prior to peening. When necessary, mask areas of part not to be peened using mechanical masks, or sufficient layers of plastic masking tape, or equivalent. Mask identification mark on parts that require a 10A or higher intensity peening, with several layers of tape.

o. If a boundary is specified for peening area, but no tolerance given, peening shall be complete within boundary, and may extend up to 0.125 inch outside boundary.

NOTE

If very few parts are to be peened and it is desired to do them without fixturing, it is permissible to peen with hand-held nozzle; however, consistent results are difficult to maintain.

p. Mount part on rotating table so that area to be peened is in exactly same position which test block occupied. When area to be peened is larger than nozzle spray pattern, set up additional fixed nozzles with overlapping spray to fully cover area to be peened.

q. It is suggested that after each hour of machine operation a small sample of shot (taken from nozzle only) be examined using a 10X magnifier. If more than 10% of shot is broken, replace entire charge in machine with new shot.

r. When required, achieve taper peening by placing designated surface in fringe area of blast stream. In taper peen area, approach zero intensity gradually with complete coverage of required surface, unless otherwise specified in work packages/subordinate work packages.

s. Blast surface of part to be peened using same conditions established with test strip(s) for obtaining required arc height, listed in step h.

t. Remove masking, if used. Clean all residue from part.

u. Inspect visually for uniformity of peening and complete coverage. Holes and edges of part shall be free from rolled metal and shot residue.

v. Preserve as required using MIL-C-15074 corrosion preventive oil.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

FEATURE CONTROL SYMBOLS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 13	0				
14 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains a general explanation of feature control symbols.

2. FEATURE CONTROL SYMBOLS.

(See Figures 1 through 10.)

a. Feature control is a sort of shorthand in block style for use on drawings, blueprints or layouts to express tolerance conditions in compact form.

b. These conditions may apply either to FORM such as parallelism or to POSITION such as concentricity.

NOTE

Feature control symbols on older drawings may be in old style format. Both old and new styles are illustrated in the following paragraphs.

c. The following explanation covers only basic symbols and a typical example, step by step.

d. Feature Control Symbol usually has three parts or blocks as per figure 1.

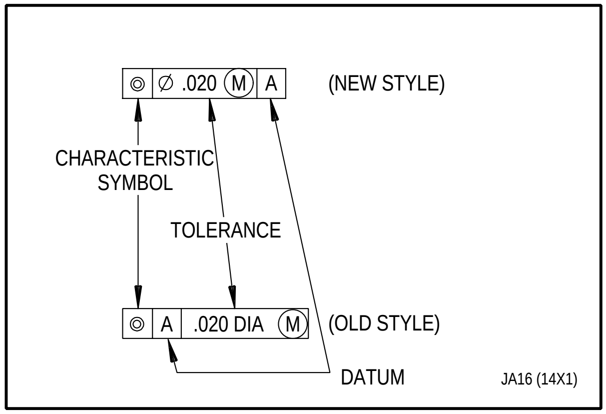


Figure 1. Typical Feature Control Symbol

(1) The Datum block may include more than one Datum as per figure 2.

(2) Characteristic symbol (figure 3) shows NATURE of tolerance.

(3) Tolerance block shows magnitude of tolerance in decimal inches.

e. Characteristic symbols are defined briefly as follows:

(1) Angularity. Surface or line at a specified angle, other than 90°, from a datum plane or axis.

(2) Circular runout. Variation during a circular trace about an axis or centerpoint.

(3) Concentricity. Features are coaxial.

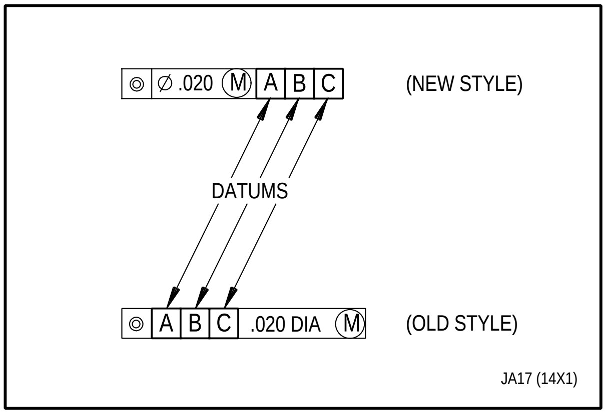


Figure 2. Symbols With More Than One Datum

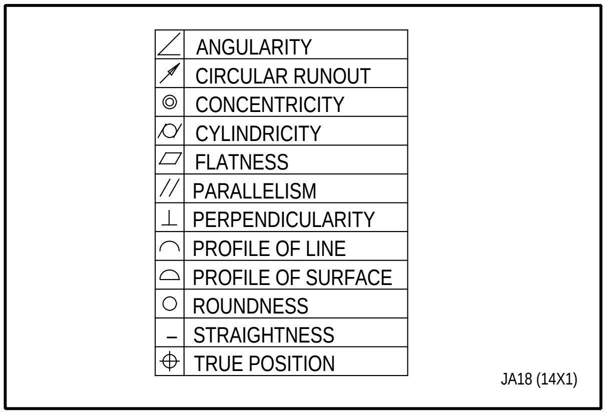


Figure 3. Characteristic Symbols

(4) Cylindricity. All elements of a surface of revolution form a cylinder.

(5) Flatness. A surface having all points in one plane.

(6) Parallelism. A surface or line equidistant at all points from a datum plane or axis.

(7) Perpendicularity. Surfaces, axes, or lines that are at right angles to one another.

(8) Profile of line. The width of a zone within which a line (of a surface) shall lie.

(9) Profile of surface. The width of a zone within which a surface shall lie.

(10) Roundness. All points on a sphere intersected by any plane passing through a common center are equidistant from the center; all points on a cylinder or cone intersected by any plane perpendicular to a common axis are equidistant from the axis.

(11) Straightness. An element (line) of a surface is a straight line.

(12) True position. The basic, or theoretically exact position for a feature.

f. The DATUMS identify the structural features, such as a particular surface or diameter, to which the CHARACTERISTIC is in reference. Sometimes no Datum is required; the Feature Control Symbol would then include only two parts, with the datum block omitted.

g. The following example will be explained step by step as per figure 4.

(1) This drawing calls for drilling eight holes, equally spaced, each having diameter of 0.334 to 0.344 inch.

(2) Feature Control Symbol tells where holes may be located in relation to Surface A and Diameter B.

(3) Holes are referred to as The Feature.

(4) First part (block) of Feature Control Symbol contains Characteristic Symbol +U02F8 for True Position.

(5) True Position means THEORETICALLY EXACT position.

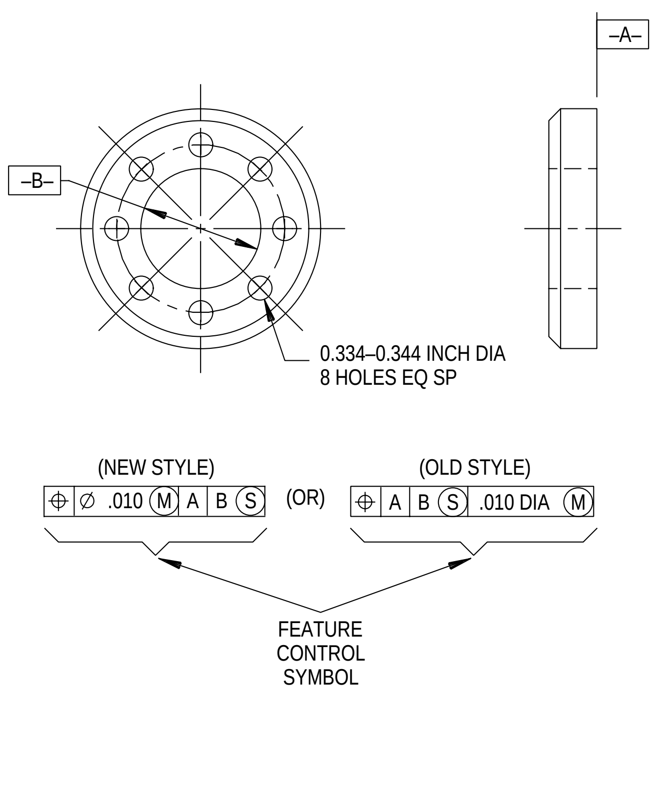


Figure 4. Typical Drawing With Feature Control Symbol

(6) The second part (block) of Feature Control Symbol shows two Datums, A and B. A is face surface of beveled ring as indicated in the drawing. B is inside diameter of ring. (The S will be explained later.) Alphabetical order is not significant, but left-to-right position is in order of IMPORTANCE. (See figure 5.) On drawing, Datums A and B are enclosed in frame, and flanked by dashes: -A- , -B- . These are called Datum identifiers, as per figure 4.

(7) Datums in this example indicate that location of holes with respect to Surface A and Diameter B may vary within certain limits. Third part (block) of the Feature Control Symbol will define these limits.

h. The third part (block) of the Feature Control Symbol will define these limits. But an explanation of M and S is necessary. These are called MODIFIERS; here is their significance:

(1) M Maximum Material Condition (MMC)

(2) S Regardless of Feature Size (RFS)

(3) M means the condition where feature contains maximum amount of material. Examples:

(a) A dowel with diameter 0.500 to 0.510 inch will have MMC at its upper limit of 0.510 inch.

(b) A hole with diameter 0.334 to 0.344 inch will have MMC at its lower limit of 0.334 inch.

(4) S means that Tolerance in Feature Control Symbol applies at any allowable dimension.

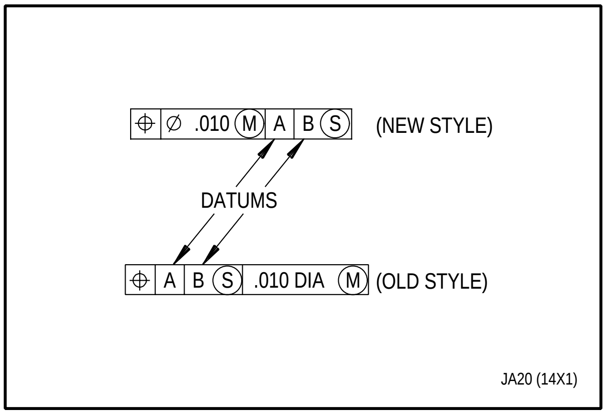


Figure 5. Typical Future Control Symbol

i. If MODIFIER appears in Datum block, it relates to dimensional tolerance of Datum identified, and is called a Datum-condition Modifier.

j. If MODIFIER appears in Tolerance block, it relates to feature itself, and is called Feature-condition Modifier.

k. Datum-condition Modifier is illustrated in figure 6. S Indicates that True Position tolerance of 0.010 inch diameter for hole location will NOT be affected by the dimension tolerance (not shown in illustration) for inside diameter of part, represented by -B- .

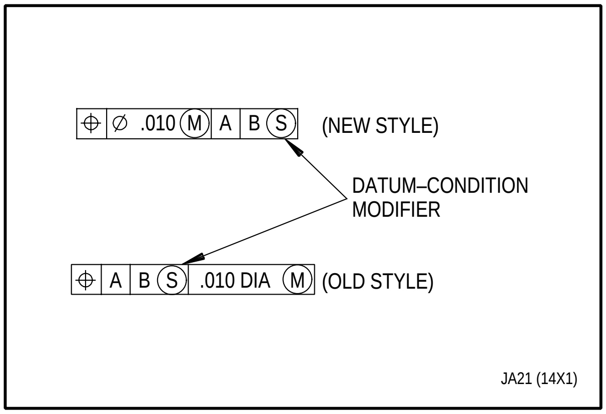


Figure 6. Significance of Datum-Condition Modifier

l. Feature-Condition Modifier is illustrated in figure 7. M Indicates that True Position tolerance of 0.010 inch diameter for hole location will be available at MMC with respect to holes; that is, when the hole has a diameter of 0.334 inch.

(1) If hole has diameter of 0.344 inch, Tolerance of 0.010 inch is then added to dimensional tolerance (0.344 inch minus 0.334 inch) to give a combined True Position tolerance of 0.020 inch.

(2) A hole diameter between limits given would mean adding appropriate difference to Tolerance of 0.010 inch. For example, if hole had actual diameter of 0.338 inch, combined tolerance would be:

+	0.004 inch	(0.338 inch minus 0.334 inch)
	0.010 inch	
	0.014 inch	combined tolerance

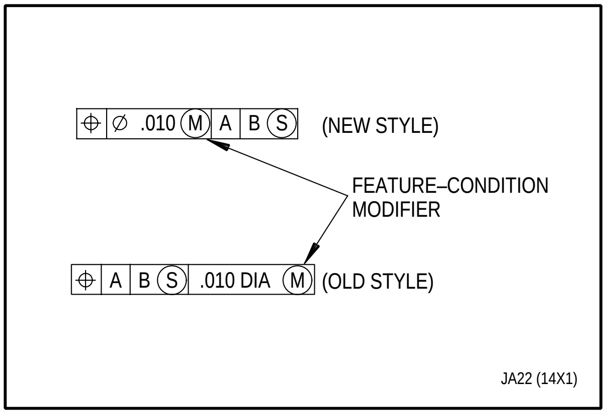


Figure 7. Significance of Feature-Condition Modifier

m. An explanation of the letters DIA or Ø appearing in Tolerance Block (figure 8) follows:

(1) Symbol DIA or Ø means that 0.010 inch is tolerance measured as a diameter.

(2) DIA or Ø is called Tolerance Zone Indicator.

(3) Only Concentricity ( )and True Position ( )require Tolerance Zone Indicator.

n. Feature Control (old style) may also use one other Tolerance Zone Indicator, the symbol TOTAL. It may appear ONLY for True Position of NONCIRCULAR feature (such as oval hole, slot, or lug), and it refers to WIDTH of tolerance zone (half on either side of basic position). In New Style, TOTAL is implied when the tolerance zone indicator Ø is omitted.

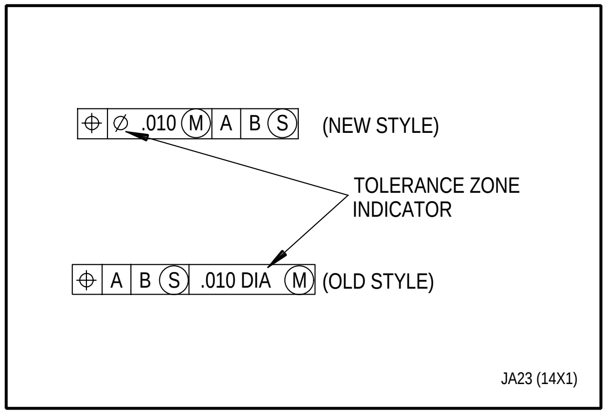


Figure 8. Significance of Tolerance Zone Indicator

o. In order to consider other combinations of Modifiers, suppose that in illustrative example, M had followed Datum B, instead of S (figure 9). Choosing dimension 3.000 to 3.005 inches for Diameter B for purpose of illustrating:

(1) MMC for Diameter B would be at 3.000 inch, using Diameter B as the ID of ring in figure 4.

(2) If actual diameter of Diameter B is 3.002 inches, the difference of 0.002 inch will then be ADDED to COMBINED tolerance for True Position.

(3) Suppose that actual hole drilled is 0.339 inch in diameter. The tolerance for location will then become:

0.010 inch	(from Feature Control Symbol)
0.005 inch	(0.339 inch minus 0.334 inch)
+ 0.002 inch	(3.002 inches minus 3.000 inches)
0.017 inch	Total combined tolerance.

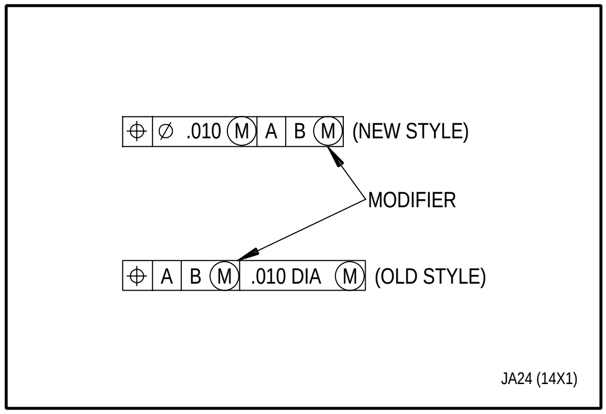


Figure 9. Alternate Modifier Combination

p. Another possible combination of Modifiers is illustrated in figure 10.

(1) In this example Modifier S is shown as Feature-Condition Modifier, and is also shown as Datum-Condition Modifier for Datum B.

(2) This arrangement indicates that the diameter tolerance for True Position will be ONLY 0.010 inch, regardless of actual toleranced ID dimension of Diameter B AND regardless of actual toleranced dimension of drilled hole.

(3) In other words, True Position location is more CLOSELY CONTROLLED.

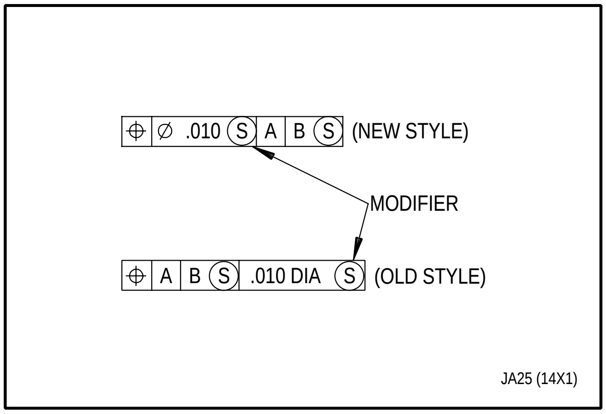


Figure 10. Alternate Modifier Combination

3. CLEARANCE ENVELOPE.

a. An important symbol sometimes appearing on drawings in connection with Feature Control is CL ENV, which stands for Clearance Envelope.

b. The Clearance Envelope is a basic dimension WITHOUT tolerance, establishing an absolute boundary for inspection purpose.

c. Inspecting by Clearance Envelope requires the use of plug or receiver gages, or mating parts in lieu of gages.

d. When CL ENV applies to an OD, it means the boundary outside of which no portion of the feature shall extend.

e. When CL ENV applies to an ID, it means the boundary inside of which no portion of the feature shall extend.

f. This method of rapid inspection guarantees that a part will fit after repair, while allowing for relaxation of otherwise closely restricted machining tolerances.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLATING PROCEDURES, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074
Tetrachloroethylene (perchlorethylene)	O-T-236
	or
Trichloroethane (inhibited, 1,1,1)	MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance plating procedures.

2. GENERAL.

a. Satisfactory plating depends upon competent personnel, adequate equipment, and careful control of solutions and operations. A securely adherent bond between plated material and underlying metal is essential, and depends upon careful preparation of parts as well as observance of each procedural step.

b. Tools, fixtures, containers, and benches shall be kept clean at all times, since these items directly affect parts being processed, and may be an indication of quality of work.

c. Parts are sometimes scheduled to be immersed in certain solutions either with or without the application of current. Ensure that electrical current is used only as specified in procedure. For example, do not assume that immersion in an electrolytic-type cleaner necessarily includes the application of current.

3. DEMAGNETIZATION.

a. Demagnetization test.

(1) All steel parts and test panels shall be checked for magnetization, and, if indicated, demagnetized prior to plating.

NOTE

An instrument for indicating magnetization is the Field Strength Indicator, available from the Magnetic Analysis Corp, 535 South 4th Avenue, Mt Vernon, NY 10553.

(2) Place indicator in contact with part or test panel with sides of meter adjacent to pivot end of pointer touching the item being tested.

(3) Move meter over all areas of part or test panel, particularly faces and rims of flanges on parts and all projections from main body.

(4) Watch needle of indicator during this procedure. Needle shall not deflect more than plus or minus one division of scale. If deflection is greater than plus or minus one division (±1 Gauss), part or test panel shall be demagnetized.

b. Demagnetization procedure.

(1) Pass part or test panel through entire length of demagnetizer.

(2) Hold part or test panel close to top or sides of demagnetizer.

(3) Withdraw part or test panel slowly.

(4) Rotate circular parts while withdrawing.

(5) Remove part or test panel straight away from demagnetizer. Do not turn off current until part or test panel is at least 3 feet from demagnetizer.

(6) Repeat demagnetization test. If necessary, repeat procedure and test until satisfactory results have been obtained.

4. CLEANING.

WARNING

Many of the chemical solutions and their components used in cleaning, inspection, and repair are harmful to skin, eyes, and respiratory system. Many of the chemicals, including their vapors, are extremely poisonous, corrosive, and react violently with incompatible materials. Improper mixing and combining of these chemicals can produce violent reactions, rapid heat generation, and explosive/toxic gasses. Heating certain chemicals will cause toxic gasses to be produced. Refer to the specific material safety data sheet for additional information.

a. Parts shall be vapor degreased. Refer to T.O. 2J-F100-53-1, SWP 031 01, as applicable, prior to plating. However, if processing is delayed for any reason, degreased part shall be protected with MIL-C-15074 corrosion preventive oil. Remove oil, as required, when ready to continue cleaning or plating procedure.

b. Parts to be plated shall be thoroughly clean, to achieve satisfactory bonding. During cleaning preparation, check frequently for water breaks (uneven or interrupted rinse flow pattern across surface). When water breaks occur, scrub area with plater's tampico or nylon brush and paste of pumice, mixed either with water, or cleaning solution last previously used for affected part, such as alkaline cleaner or smut remover. Rinse again in clean water. Repeat as necessary, until water breaks are absent. Dry with clean, dry, compressed air at not more than 30 psig discharge pressure.

5. MASKING.

a. Masking materials include wax, lacquer, tape, and rubber-like materials. Selection depends upon composition and temperature of plating solution, and duration of immersion. Most waxes are limited to a maximum of 135°F (57°C). Lacquer may withstand 200°F (93°C) for a short period; then for continued use, is limited to 130°F (54°C) maximum. Some special lacquers can withstand higher temperature in acid solution, but are not suitable in alkaline solution at 160°F (71°C) or higher.

b. Shapes, sizes, and types of surface also affect selection of masking material. Since lacquer shrinks upon drying, adherence on curved surfaces is difficult unless retained by lacquering over an adjacent edge.

c. Masking wax shall adhere to part being plated, without staining underlying metal, and shall be insoluble in plating solution used. Masking wax shall be nonchlorinated, and have a minimum melting point of 165°F (74°C), and a minimum flash point of 450°F (232°C). Waxes listed in T.O. 2J-F100-53-1, SWP 092 12 comply with these requirements.

d. Masking lacquer shall air dry to touch in less than 30 minutes after spraying at 30 to 50 psig, and be ready for use after 2 hours. Lacquer shall be insoluble in plating solution used, and adhere to part being plated. Lacquer shall not stain underlying metal if immersed in heavy duty alkaline cleaner for 1.5 minutes, or in any plating solution for 3 hours. Lacquers listed in T.O. 2J-F100-53-1, SWP 092 12 comply with these requirements.

6. PLATING.

a. Selection of fixtures shall depend upon types of solutions. Fixtures shall be replaced when deteriorated by age or usage.

b. Plating solutions (except strike solutions) require constant agitation.

DEFINITIONS

FLASH - Never as an undercoat. Usually approximately 0.0001 inch thick. Used for oxidation or corrosion protection or improved appearance.

STRIKE - Always as an undercoat. May be 0.000005 inch up to or exceeding 0.0001 inch thick, but usually less than 0.0002 inch thick. May be plated with the same or different material as topcoat, but if same, then it shall be with a different type of plating solution.

c. After plating, masking lacquer may be quickly removed by washing with, or immersion in hot tetrachloroethylene (perchlorethylene) or trichloroethane. An alternate method is loosening by immersion in hot alkaline cleaner until lacquer can be blown off with air blast, at not more than 30 psig discharge pressure.

7. BAKING.

a. Baking temperatures shall be those given in plating procedure, unless otherwise specified in WP/SWP.

b. Some steel parts require stress-relief as high as 700° to 800°F (371° to 427°C); however, such temperatures shall not be used unless specified by WP/SWP, since effects of shotpeening and case hardening, especially on carburized parts, are destroyed at these temperatures.

c. Baking for stress-relief after grinding, or for preventing hydrogen embrittlement after plating shall be done as soon as possible, and not more than 36 hours after grinding or plating, unless Time Lapse instructions per WP/SWP apply. These items shall be stress-relieved within established Time Lapse limits.

d. Unless otherwise specified in WP/SWP, maximum temperature shall be 350°F (177°C). Carburized parts may be baked at 290° to 420°F (143° to 216°C), with 350°F (177°C) preferred.

e. To remove stains on steel parts caused by high temperature baking and surface tempering operations, proceed as follows:

(1) Degrease part; rinse in clean running water.

(2) Using a current density of 25 60 amperes per square foot and a periodic reverse cycle of 5 seconds anodic and 30 seconds cathodic, immerse part in PS 211 alkaline smut removal solution for 1 to 3 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance. Current shall be anodic at end of cycle, and shall be OFF when immersing or withdrawing parts.

(3) Rinse thoroughly in clean running water. If any stains remain, brush or swab part with paste of grade FFF pumice and water.

(4) Rinse again in clean running water and if stains remain, repeat step e.(1) through (3).

(5) Rinse part in clean, hot water and dry in an air blast at not more than 30 psig discharge pressure.

8. PRESERVATION.

a. Preserve as required using MIL-C-15074 corrosion preventive oil.

9. REFERENCE LIST.

(See Table 1.)

a. The following list includes the SWP number for each plating or stripping procedure, its title, and a cross-reference to AMS specification(s). Minor differences may exist between SWP procedures and related AMS specifications. This is usually due to the addition of specific details, improved technique, or adaptation for Depot Maintenance conditions. In each case, the intent of the AMS specification is satisfied.

Table 1. Plating/Stripping Reference List

SWP	Procedure	AMS
092 04	Chromium plating on aluminum	2406
092 05	Cadmium plating	2400
092 06	Chromium plating on steel	2406
092 07	Silver plating on steel (not stainless)	2412
092 08	Silver plating on stainless steel	2410
092 09	Nickel-cadmium plating	2416
092 10	Nickel plating on stainless steel, cobalt, 2403, 2424 and nickel base alloys	2403, 2424
092 11	Nickel plating on steel (not stainless)	2403, 2424
092 12	Masking of parts	-
092 13	Aluminum hardcoating	2468
092 14	Stripping nickel and nickel-cadmium plate from silver and copper alloy brazed parts	-
092 15	Chemical chromate conversion treatment for magnesium alloys	-
092 16	Anodize touch-up, brush or swab method	2473
092 17	Nickel-cadmium barrel plating	2416
092 18	Nitric acid stripping of plasma coatings	-
092 19	Caustic soda stripping of plasma coatings	-
092 20	Nickel strip solution stripping of plasma coatings	-
092 21	Nitric-phosphoric acid stripping of PWA 47, PWA 73, and PWA 273 aluminide coatings from PWA 655, PWA 656, PWA 663, PWA 1422, and PWA 1455 parts	-
092 22	Accelerated (acid) stripping of nickel cadmium plate from martensitic stainless steel compressor blades	-

Table 1. Plating/Stripping Reference List (continued)

SWP	Procedure	AMS
092 23	Acid cleaning of titanium and titanium alloys	-
092 24	Nitric-sulfuric acid stripping of plasma coatings	-
092 25	Stripping silver or copper brazing alloy from corrosion and heat resistant steel	-
092 26	Stripping of PWA 77 aluminide coating	-
092 27	Nitric acid stripping of PWA 26, PWA 27, PWA 45, PWA 47, PWA 63, PWA 73, and PWA 273 aluminide coating from PWA 647, PWA 652, PWA 653, PWA 654, PWA 655, PWA 656, PWA 657, PWA 658, PWA 663, PWA 664, PWA 1038, PWA 1066, PWA 1422, PWA 1451, PWA 1455, and PWA 1456 parts	-
092 28	Electroless nickel plating	2404
092 29	Nickel-cadmium plate stripping with preservation of underlying nickel plate repairs	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - SILVER PLATE, BOND TESTING

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Peening, Steel Shot (SPOP 501) - - - - - - - - - - - - - - - -	SWP 091 08

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance bond testing of silver plate.

2. BAKING.

a. Following silver plating, all high speed steel or stainless steel parts shall be stress-relieved by baking at 375°F (191°C) for 2 hours, prior to bond testing.

3. TEST OF SILVER PLATE UNDER 0.002 INCH THICK.

a. In an area outside the plating envelope, scrape excess plate from interface, using a knife, razor blade, or pointed pick. If possible, repeat at five or more locations.

b. Examine with a 6 to 10X magnifier. If plate has separated from interface in a distinct layer at any location, bond is unsatisfactory.

4. TEST OF SILVER PLATE 0.002 INCH THICK OR OVER, BY CHISEL TEST.

(See Figure 1.)

NOTE

This test may also be applied in an identical manner to soft nickel plate.

a. Clamp part in bench vise, exposing plated area outside plating envelope, such as excess plate built up at an edge.

b. Hold special chisel (fabricated per figure 1) almost parallel (or tangent) to the excess plated surface.

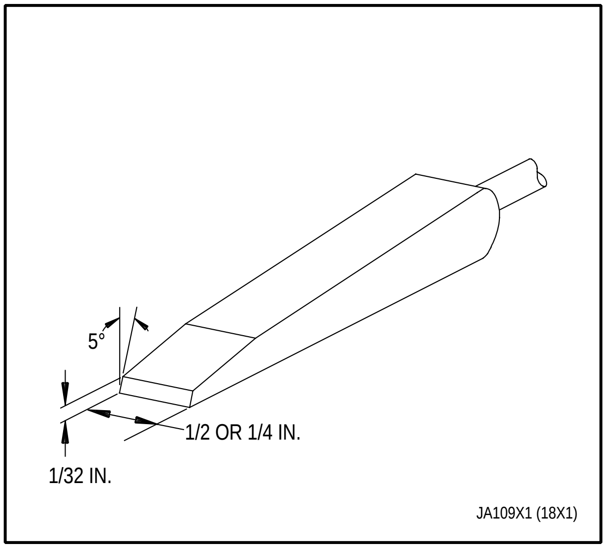


Figure 1. Silver Bond Test Chisel

c. Tap chisel until blade end is just below interface of basis metal and silver plate. Continue tapping so that chisel shears plate at interface. Do not allow shear path to enter any plating envelope. If possible, repeat at five more locations.

d. Examine with a 6 to 10X magnifier. If plate has separated as a layer from basis metal, or from strike beyond sides or ends of any shear path, bond is unsatisfactory.

5. TEST OF SILVER PLATE 0.004 to 0.027 INCH THICK BY SHOTPEENING.
(See Figure 2.)

a. Inspect all parts for thickness of silver plate, using a Magne-Gage, available from the American Instrument Co, 8030 Georgia Ave, Silver Spring, MD 20910. Do not apply the shotpeening test to any parts with a silver plate less than 0.004 inch or thicker than 0.027 inch, or having more than 0.005 inch variation in thickness.

b. Mark each acceptable part with maximum plate thickness which was measured.

c. Arrange all parts to be tested in groups, within which plating thickness variation is not more than 0.005 inch.

d. Select minimum arc height for maximum thickness of each group of parts per shotpeen bond test chart. (See figure 2.) Peen Almen A test strips to determine pressure which will produce desired arc height, using SAE S170 cast shot, per T.O. 2J-F100-53-1, SWP 091 08. Adjust peening intensity by test strips before starting each group of parts, and again each hour if the group so requires.

e. Shotpeen each group per T.O. 2J-F100-53-1, SWP 091 08 using S170 shot to minimum arc height for maximum thickness of particular group per figure 2.

f. The presence of blisters or ruptures in the plated surface shall indicate an unsatisfactory bond.

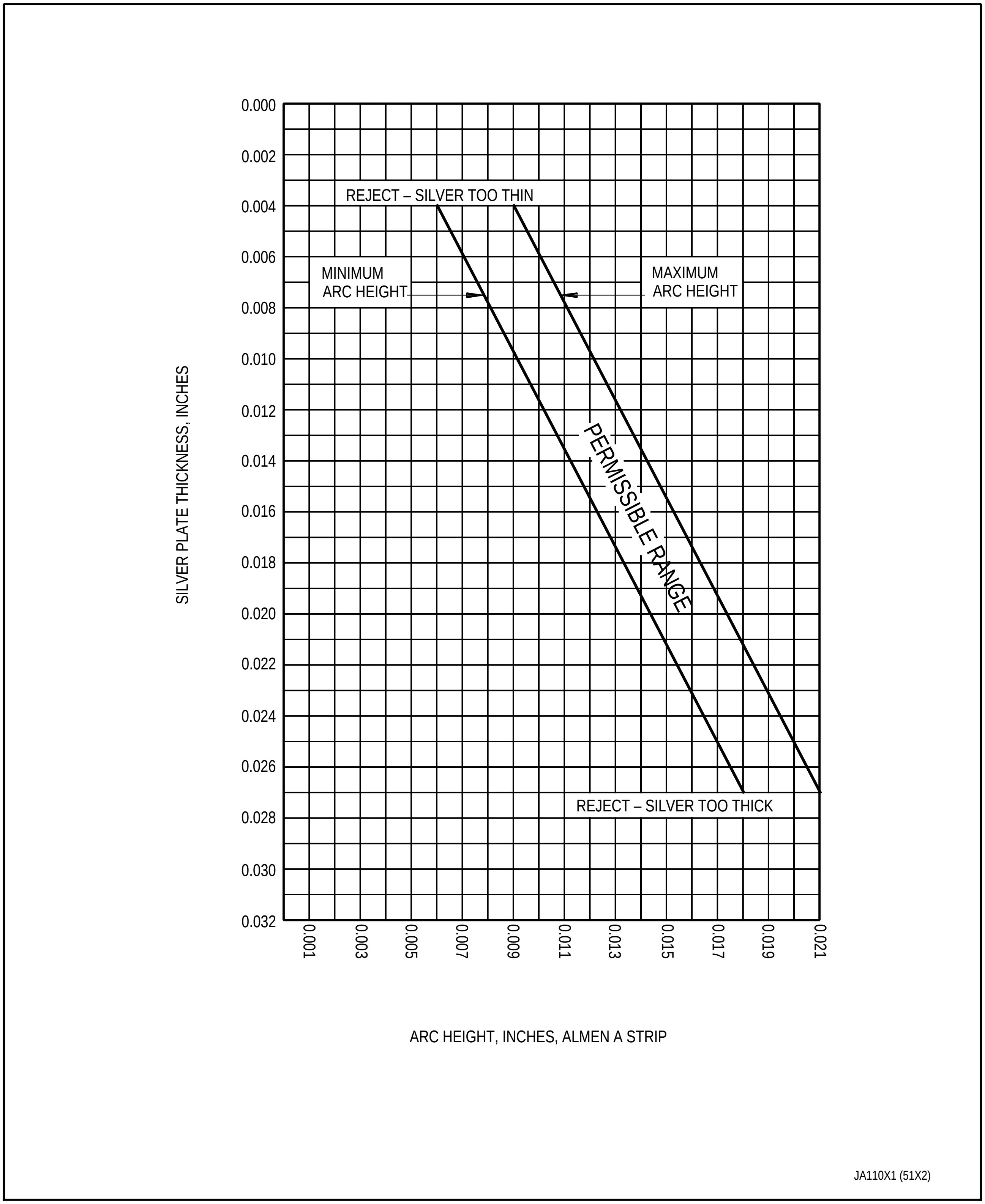


Figure 2. Shotpeen Bond Test Chart

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

CHROMIUM PLATE, INSPECTION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures - - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Copper sulfate	O-C-828
Oil, corrosion preventive	MIL-C-15074
Sulfuric acid	O-S-809

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance inspection of chromium plate.

2. TEST FOR PRESENCE OF CHROMIUM PLATE ON LOW ALLOY STEEL.

a. Clean and dry area to be tested.

WARNING

Sulfuric acid causes burns, and may react violently if brought into contact with water improperly. Add sulfuric acid into water slowly. Never pour water into sulfuric acid. Protect eyes, skin, and clothing from contact. Use face mask, rubber gloves, and rubber apron.

b. Prepare testing solution as follows:

(1) Measure a weight of water equivalent to 97.5% of desired volume.

(2) Measure a weight of O-S-809 sulfuric acid equivalent to 0.5% of desired volume, and add slowly and carefully to the water, stirring constantly.

(3) Measure a weight of O-C-828 copper sulfate crystals equivalent to 2.0% of desired volume, and add to water-sulfuric aci mixture. Stir until dissolved.

c. Apply testing solution to area to be tested.

d. Observe for any color change. Any low alloy steel area (chromium plate absent) will be tinted copper-colored almost at once. Chromium plated areas will remain unchanged.

e. Rinse in clean, hot water.

f. If part is not to be plated immediately, dry with an air blast and apply corrosion preventive oil.

3. CHIPPING LIMITS FOR CHROMIUM PLATED PISTON-LIKE PARTS WITH CIRCUMFERENTIAL GROOVES.

a. Where OD plating encompasses fewer than two circumferential grooves per inch of part length, chipping at edge of chromium plate is acceptable provided that chipped area extends no more than 0.0469 inch back from an edge and, for 75% of groove circumference, edge shows no chipping.

b. Where OD plating encompasses two or more circumferential grooves per inch of part length, chipping on OD lands is acceptable within limits shown below provided no two adjacent lands are both chipped, and chipped areas on same land or on two alternate lands do not occur on same axial line.

NOTE

This limit does not apply to chromium plated faces mating with carbon seals.

c. Chipped areas on an edge of a chromium plated face are acceptable, provided each chip extends radially no more than 0.0469 inch from either edge. Number is not important, provided at least 75% of the plate boundaries shows no edge chipping.

OD Land Width	Acceptable Edge Chipping (Maximum)	Acceptable Circumferential Chipping (Maximum)
Thru 0.070 inch	0.0156 inch	
Over 0.070 inch thru 0.080 inch	0.0312 inch	25% of circumference; number of chipped areas not important.
Over 0.080 inch	50% of actual land width, up to 0.0469 inch	

4. MINUTE CRACKS IN CHROMIUM PLATE.

NOTE

- A crack is defined as a break in the material.
- A minute crack is defined as a very tiny crack requiring magnification or side-lighting in order to be visible.

a. A lace-like network of minute cracks in chromium plate is referred to as crazing or alligatoring, and is a normal and acceptable condition. This appearance is typical on flat surfaces, but may also occur on large OD or ID surfaces. (Refer to T.O. 2-1-111, Standard Maintenance Procedures, Chapter 13 for a photograph illustrating this condition.)

b. Minute straight line axial cracks in chromium plate on OD or ID curved surfaces are normal and acceptable. Minute straight line cracks occurring elsewhere are not acceptable. Straight line circumferential cracks of any size on curved surfaces are not acceptable. (Refer to T.O. 2-1-111, Standard Maintenance Procedures, Chapter 13 for a photograph illustrating straight line axial cracks in Chromium Plate.)

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - NICKEL-CADMIUM PLATE, TEST FOR PRESENCE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetic acid	O-A-76
Ammonium acetate	-
Ammonium hydroxide	O-A-451, Type I
Copper sulfate	O-C-828
Dimethylglyoxime	-
Enamel, aluminum-silicone	DuPont Type 2, Formula 612-70 (or) Isis Formula LB-304 (or) Pratt & Lambert Formula 7897, Type 1
Nitric acid	O-N-350
Oil, corrosion preventive	MIL-C-15074
Sulfuric acid	O-S-809

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance testing for the presence of nickel-cadmium plate.

2. PROCEDURE A.

CAUTION

This procedure is destructive to coating in test area. Although test area is touched up afterward, keep as small as practical, and confine to least critical region of part.

NOTE

This procedure may also be used to test for presence of nickel plate.

a. Clean area to be tested by wiping with a cloth moistened with degreasing solvent.

b. Clean spot lightly with fine abrasive paper.

c. Prepare testing solution as follows:

(1) Measure desired quantity of water (about 97% of final solution).

WARNING

Sulfuric acid causes burns, and may react violently if brought into contact with water improperly. Add sulfuric acid into water slowly. Never pour water into sulfuric acid. Protect eyes, skin, and clothing from contact. Use face mask, rubber gloves, and rubber apron.

(2) Measure a weight of O-S-809 sulfuric acid equivalent to 0.7% of desired quantity, and add slowly and carefully to the water, stirring constantly.

(3) Measure a weight of O-C-828 copper sulfate crystals equivalent to 2.2% of desired quantity, and add to water-sulfuric acid mixture. Stir until dissolved.

d. Saturate a cotton-tipped applicator with copper sulfate testing solution, and touch it to cleaned area. Presence of cadmium (in nickel-cadmium plate) will cause a coppery color to appear immediately. Since bare steel also produces this coppery color, validity of this test depends upon confirmation that a coating is present.

e. For detection of nickel plate, continue to abrade surface and alternately apply copper sulfate test solution. A gradually increasing yellowish-gray spot indicates presence of nickel plate. If spot is abraded until basis steel is exposed, test solution will produce coppery color, unless metal is martensitic stainless steel.

f. If nickel-cadmium test is positive, and coating is otherwise acceptable for continued service, remove all traces of coppery-colored deposits from test area using fine abrasive paper.

g. Touch up test area by brushing or spraying one coat of heat resistant aluminum-silicone enamel.

h. Bake enamel at 475° to 525°F (246° to 274°C) for 90 minutes minimum.

3. PROCEDURE B.

NOTE

This procedure will detect the presence of nickel in nickel plate, nickel-cadmium plate, or nickel as a steel component; however, it will not distinguish between the three, and additional means of testing may be required.

a. Prepare testing solution as follows:

(1) Dissolve one gram dimethylglyoxime in 50 ml acetic acid.

(2) Add 10 ml water and 30 ml ammonium hydroxide.

(3) Stir until all salts are dissolved.

(4) Add 10 grams ammonium acetate and stir.

(5) Filter solution if necessary.

b. Clean a small spot on part by abrading with a file or abrasive paper to remove rust and stains.

c. Place one drop of nitric acid on prepared spot and allow to react for 10 seconds.

d. Blot spot with white blotting paper or acid-resistant filter paper.

e. Place one drop of dimethylglyoxime testing solution on blotted area of paper.

f. Interpret resulting color as follows:

(1) Very deep red indicates nickel content greater than 3.5%.

(2) Pink indicates nickel content approximately 1.0 to 1.5%.

(3) Brown indicates absence of nickel, as in carbon steel.

g. Rinse spot on part which had nitric acid applied, with hot water and blow dry with compressed air.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, CHROMIUM, ON ALUMINUM (SPOP 20)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0				
8 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, Corrosion preventive	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance chromium plating on aluminum.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped per T.O. 2J-F100-53-1, SWP 092 12	As reqd	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean.	0.1 to 0.2 Max	PS 211 or 223	110 to 130	43 to 54
			Alternates: PS 101 or 201	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
3	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 12 is a strong acid and will burn skin and clothing. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Immerse in stripping solution. NOTE Current will drop gradually until stripping is complete. Stripped areas now have an anodic film which will be removed when part is replated.	As reqd	PS 12 Anodic at 70 amperes per square foot (ASF)	Room	Room
5	Clean water rinse.	0.5	Water	Room	Room
6	Remove masking material.	2 to 10	-	-	-
7	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
8	Air dry.	As reqd	Shop air	-	-
9	Preserve in oil if procedure not to continue immediately.	0.5 to 1.0	MIL-C-15074	Room	Room
10	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
11	No baking is required unless specified for a particular part.	-	-	-	-
12	Mask as required. Refer to T.O. 2J-F100-53-1, SWP 092 12.	As reqd	-	-	-
13	Clean water rinse.	0.5	Water	Room	Room
14	Alkali clean.	0.1 to 0.2 Max	PS 211 or 223 Alternates: PS 101 or 201 *If parts are masked with wax, temperature shall not exceed 135°F (57°C).	110 to 130 120 to 210*	43 to 54 40 to 99*
15	Clean water rinse.	0.5	Water	Room	Room
16	Immerse in etching solution	0.3 to 0.5	PS 48	Room	Room
17	Clean water rinse.	0.5	Water	Room	Room
18	Immerse in zincate solution. Vigorously agitate the parts.	0.3 to 0.5	PS 30	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19	Clean water rinse.	0.5	Water	Room	Room
20	Immerse in nickel plating solution. Current to be ON when immersing parts.	*	PS 321; 30 ASF *Immerse long enough to plate 0.0002 to 0.0004 inch thick. 30 ASF deposits approximately 0.0003 inch of nickel in 12 minutes.	115 to 130	46 to 54
21	Clean water rinse.	0.5	Water	Room	Room
22	Immerse in chromium plating solution. Current to be ON when immersing parts.	As reqd.	PS 115, 119 or 121* 1.5 to 5.0 amperes per square inch *An equivalent solution which satisfies the requirements of AMS 2406 may be used as an alternate.	115 to 135	46 to 57
23	Clean water rinse.	0.5	Water	Room	Room
24	Immerse in neutralizing solution.	0.1 to 0.2	PS 52 Alternates: PS 101 or 201	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
25	Clean water rinse.	0.5	Water	Room	Room
26	Remove any masking.	2 to 10	-	-	-
27	Hot water rinse.	0.5	Water	150 to 185	66 to 85
28	Air dry.	As reqd	Shop air	-	-
29	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
30	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
31	Bake as specified for part per WP/SWP.	As reqd	-	-	-
32	Inspect plate and preserve in oil as required.	1 to 20	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, CADMIUM (SPOP 21)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser	SWP 031 01
Masking Procedures	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance cadmium plating.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. No current.	1 to 3	PS 211 or 223	110 to 130	43 to 54
			Alternates: PS 101 or 201	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
3	Clean water rinse.	0.5	Water	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto, then dries on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

CAUTION

Do not substitute any other strip solution. Underlying nickel plate repairs could be damaged.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Immerse in strip solution.	As reqd	PS 590	Room	Room
5	Clean water rinse.	0.5	Water	Room	Room
6	Remove masking material.	2 to 10	-	-	-
7	Alkali clean. No current. NOTE Holding time up to 45 minutes is permissible.	0.2 to 0.4	PS 211 or 223 Alternates: PS 101 or 201 *If parts are masked with wax, temperature shall not exceed 135°F (57°C).	110 to 130 120 to 210*	43 to 54 49 to 99*
8	Clean water rinse.	0.5	Water	Room	Room
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
11	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
12	Bake parts having a hardness of Rockwell C40 or higher which have been repaired by grinding or machining.	120	-	290 to 310	143 to 154
13	Mask as required per T.O. 2J-F100-53-1, SWP 092 02. NOTE • Use fixture design for particular parts when specified per WP/SWP. • For low alloy steels, if PS 211 or 223 is used, Operations 16 through 21 may be omitted.	5 to 20	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
14	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201; anodic only at 10 to 15 ASF.	120 to 210*	49 to 99*
			* If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
15	Clean water rinse. Pumice clean, then rinse again.	1 to 3	Water Pumice, Grade FFF Plater's brush	Room	Room
16	(Low Alloy Steel Parts Only) NOTE Operations 16 through 21 may be omitted if PS 221 or 223 was used in Operation 14.				
	Immerse in acid bath. No current.	0.3 to 0.6	PS 53	90 to 110	32 to 43
			Alternates: PS 13, 19, 25, 50, 54 or 138		
			or PS 3	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
16 (con't)	(Stainless Steel Parts Only) Immerse in acid bath.	0.5 to 0.6	PS 53; cathodic only, 20 to 60 ASF Alternates: PS 13, 19, 25, 50, 54, or 138; cathodic only, 20 to 60 ASF	Room	Room
17	Clean water rinse.	0.5	Water	Room	Room
18	(Stainless Steel Parts Only) Immerse in nickel strike solution.	4 to 6	PS 14; 35 to 75 ASF for 300 ampere-minutes per square foot, minimum. EXAMPLE: 5 minutes at 60 ASF. NOTE Threaded parts require 400 to 500 ASF.	Room	Room
19	Clean water rinse.	0.5 to 1.0	Water	Room	Room
20	Immerse in neutralizing solution.	0.3 to 0.6	PS 52 Alternates: PS 101 or 201	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
21	Clean water rinse.	0.5 to 10 maximum	Water	Room	Room

WARNING

PS 301 contains cyanide, and cadmium salts, both of which are extremely poisonous. Ensure no personal contact. Use adequate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
22	Immerse in cadmium plating solution.	As reqd	PS 301; 15 to 25 ASF	Room	Room
23	Clean water rinse.	0.5 to 5.0	Water	Room	Room
24	(Optional) Remove fixtures from unmasked parts.	1 to 2	-	-	-
25	Immerse in brightener solution.	0.3 to 0.6	PS 480	Room	Room
26	Clean water rinse.	0.5 to 1.0	Water	Room	Room
27	Remove any masking.	2 to 10	-	-	-
28	Clean water rinse.	0.5 to 1.0	Water	Room	Room
29	Hot water rinse.	0.5 to 1.0	Water	150 to 185	66 to 85

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
30	Air dry.	1.0 to 3.0	Shop air	-	-
31	Inspect plate.	As reqd	-	-	-
32	Preserve in oil if procedure not to continue immediately.	0.5 to 1.0	MIL-C-15074	Room	Room
33	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
34	Paint contact areas if specified per WP/ SWP.	-	-	-	-
35	Bake springs and any parts having a hardness of Rockwell C45 or higher.	120	-	440 to 460	227 to 238
	Bake any parts coldworked after heat treat or having hardness of Rockwell C33 to C45.	180	-	365 to 385	185 to 196
	Bake any parts which would be adversely affected if baked at the preceding higher temperature.	300	-	290 to 310	143 to 154

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, CHROMIUM, ON STEEL, NICKEL, OR COBALT (SPOP 22)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 10	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Peening, Steel Shot (SPOP 501)	SWP 091 08
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance chromium plating on steel, nickel, or cobalt.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

Plating chromium over existing chromium plate is accepted practice, with careful control of both preplating processing and plating procedure; however, parts having both bare steel and chromium plate (worn chromium plate) shall be stripped and replated, since control of plating in this case is impractical.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Grind if necessary, to remove heavy, old chromium plate.	As reqd	-	-	-
2	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
3	Mask areas not to be stripped per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Strip chromium plate by either Method I or Method II:				
	Method I:				
	Immerse in stripping solution. Current to be OFF when immersing or withdrawing parts.	As reqd.	PS 101 or 117; anodic, 5 to 7 volts	120 to 210*	49 to 99*

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4 (con't)			* If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
	Method II:				
	a. Alkali clean by immersion only. No current.	1 to 3	PS 101 or 201	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
	b. Cold water rinse.	0.5	Water	Room	Room

CAUTION

Check parts frequently during stripping, and remove as soon as complete. Remove immediately if basis metal of part is being attacked.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	c. Immerse in acid stripping solution. Approximately 0.001 inch thickness of chromium plate will be stripped per hour.	As reqd	PS 31, 47, or 123	Room*	Room*
			*For stainless steel or nickel alloys, temperature may be raised to 150°F (60°C) to increase stripping rate.		
	d. Cold water rinse.	0.5	Water	Room	Room
	e. Immerse in alkaline neutralizing solution.	0.5 to 1.0	PS 101 or 201	Room	Room
5	Cold water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	(Optional) Wet glass bead blast, T.O. 2J-F100-53-1, SWP 031 03, may be used for further cleanup, if desired.	-	-	-	-
7	Remove any masking.	2 to 10	-	-	-
8	Hot water rinse.	1.0 to 1.5	Water	150 to 185	66 to 85
9	Air dry.	As reqd	Shop air	-	-
10	Inspect for completeness of strip.	As reqd	-	-	-
11	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
12	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
13	Bake parts having a hardness of Rockwell C40 or higher.	60	-	290 to 310	143 to 154

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

- Shotpeening may be omitted, provided part will be baked after plating. See CAUTION at Operation 27.
- Both shotpeening before plating, and baking after plating may be omitted for certain noncritical parts. This is indicated for specific part in WP/SWP.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
14	Shotpeen surface to be plated. Refer to T.O. 2J-F100-53-1, SWP 091 08, to an intensity of 12A, unless otherwise specified per WP/SWP. Peening shall extend beyond area to be plated.	As reqd	-	-	-
15	Mask as required. Refer to T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
16	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201; anodic only at 10 to 15 ASF.	120 to 210*	49 to 99*
			* If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
17	Clean water rinse.	0.5	Water	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Omit this Operation for nonstainless steel parts.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
18	a. Immerse in acid etching solution.	1.0	PS 53; anodic only. 60 ASF. Alternates: PS 25, 54 or 138	Room	Room
	b. Clean water rinse.	0.5	Water	Room	Room
19	a. Immerse in alkali solution to remove smut, using no current.	0.5	PS 211 or 223	110 to 130	43 to 54
	b. (Omit if smut was completely removed in step a.) Apply current.	1.0	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
	c. Clean water rinse.	0.5	Water	Room	Room
	d. (Stainless Steel Parts Only) Immerse in acid etching solution. No current.	0.5 to 1.0	PS 53 Alternates: PS 25, 54 or 138	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19 (con't)	e. (Nickel or Cobalt Alloy Parts Only) Immerse in acid etching solution. No current.	0.1 to 0.2	PS 48 Alternates: PS 38 or 222	Room	Room
	f. Clean water rinse.	0.5	Water	Room	Room

NOTE

Do not apply current until parts are at solution temperature.

20	Immerse in chromium plating solution.	As reqd	PS 115, 119, 121 or an equivalent solution which satisfies the requirements of AMS 2406.	115 to 135	46 to 57
	(Nonstainless Steel Parts Only) Make anodic.		Anodic 2 minutes at 0.4 amperes per square inch.		
	(All parts) Chromium plate.		Cathodic 2 minutes at 0.4 amperes per square inch. Then raise slowly to 1.5 to 5.0 amperes per square inch, and hold until required thickness chromium plate is obtained.		

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
21	Clean water rinse.	0.5 to 1.0	Water	Room	Room
22	Immerse in alkaline neutralizer.	0.2 to 0.3	PS 101 or 117 * If parts are masked with wax, temperature shall not exceed 135°F (57°C).	120 to 210*	49 to 99*
23	Cold water rinse.	0.5	Water	Room	Room
24	Remove any masking.	2 to 10	-	-	-
25	Hot water rinse.	0.5	Water	150 to 185	66 to 85
26	Air dry.	1.0 to 1.5	Shop air	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

- Baking shall be omitted for certain parts (such as carburized steel) adversely affected by bake temperature. Shotpeening before plating (Operation 14) is required for these parts. This is indicated for specific part in WP/SWP.
- Baking may be omitted, provided part was shotpeened before plating (Operation 14). However, some noncritical parts do not require either shotpeening or post-baking. This is indicated for specific part in WP/SWP.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
27	a. Bake parts subject primarily to tensile stress in service, if applicable, per Operation 14. (Example: straps, seal rings, bushings)	180 min	-	365 to 385	185 to 196
	b. Bake parts subject primarily to fatigue stress in service, if applicable, per Operation 14. (Example: stator, rotor components)	120 min	-	600* to 750	316* to 399
			* Use highest practicable temp. in above range, while maintaining required strength and hardness.		
28	Immerse in corrosion preventive oil as necessary.	0.5 to 1.0	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, SILVER, ON STEEL (NOT STAINLESS) (SPOP 23)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser	SWP 031 01
Masking Procedures	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance silver plating on steel (not stainless steel).

Operation NO.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation NO.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 150 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201; anodic only at 10 to 15 ASF.	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
3	Clean water rinse.	0.5	Water	Room	Room

WARNING

PS 316, 322 and SPS contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	a. Immerse in alkaline strip solution until all plate is removed. No current.	As reqd	PS 316, 322 or SPS 26.	120 max.	49 max.
	b. (Alternate) Make anodic and agitate PS 310 strip solution.	As reqd	(Alternate) PS 310; anodic, 10 to 15 ASF	Room	Room
5	Clean water rinse.	0.5	Water	Room	Room
6	Remove any masking.	2 to 10	-	-	-
7	Alkali clean by immersion only. No current.	1 to 3	PS 211 or 223	110 to 130	43 to 54
			Alternates: PS 101 or 201	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
8	Cold water rinse.	0.5	Water	Room	Room
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10	Air dry.	1.0	Shop air	-	-
11	Preserve in oil if procedure not to continue immediately	0.5 to 1.0	MIL-C-15074	Room	Room
12	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
13	Bake parts having a hardness of Rockwell C40 or higher, which have been repaired by grinding or machining.	120	-	290 to 310	143 to 154
14	Mask as necessary per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-
15	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic; 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates; PS 101 or 201; anodic only, 10 to 15 ASF.	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
16	Clean water rinse.	0.5	Water	Room	Room

CAUTION

Ensure positive contact between fixture and part to prevent arcing.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
17	Immerse in acid etch solution.	0.8 to 1.0	PS 53 Alternates PS 3 or PS 13, 19, 25, 50, 54 without current; or PS 138, anodic 200 ASF.	Room 90 to 110 Room	Room 32 to 43 Room
18	Clean water rinse.	0.5	Water	Room	Room
19	Immerse in neutralizing solution.	0.3 to 0.5	PS 52 Alternates: PS 101 or 201	Room	Room
20	Clean water rinse.	0.5	Water	Room	Room

WARNING

PS 304 alkaline copper cyanide is extremely poisonous.
Ensure no personal contact. Use adequate protection.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
21	Immerse in copper strike solution. Current to be ON when immersing and withdrawing parts.	3 to 5	PS 304; 15 to 45 ASF of exposed areas of parts and fixtures.	120 to 130	49 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
22	Clean water rinse.	0.5	Water	Room	Room

WARNING

PS 305 and 306 alkaline silver cyanide solutions are extremely poisonous. Ensure no personal contact. Use adequate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
23	Immerse in silver strike solution. Current to be ON when immersing parts.	0.3 to 0.6	PS 305; 15 to 35 ASF of exposed areas of both parts and fixtures.	Room	Room
24	Immerse in silver plating solution. Current to be ON when immersing parts.	As reqd	PS 306 or 306 with PS 307; 10 to 25 ASF of exposed areas of both parts and fixtures.	130 max.	54 max.
25	Clean water rinse.	0.5	Water	Room	Room
26	Remove any masking.	2 to 10	-	-	-
27	Remove stains from plated areas.	1 to 2	Pumice, Grade FFF	-	-
28	Cold water rinse.	0.5	Water	Room	Room
29	Remove excess plate, using step a., b., or c. below. a. Using emery cloth or crocus cloth. b. Using a speed lathe or air gun with a wire brush, followed by emery cloth or crocus cloth. c. Using masking and chemical stripping per this SWP, Operations 1 through 8.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
30	Hot water rinse.	0.5	Water	150 to 185	66 to 85
31	Preserve in oil if procedure not to continue immediately.	0.5 to 1.0	MIL-C-15074	Room	Room
32	Degrease per T.O. 2J-F100-53-1,SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
33	Bake.	120	-	290 to 310	143 to 154
34	Inspect plate and preserve as required.	1 to 20	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, SILVER, ON STAINLESS STEEL OR NICKEL (SPOP 24)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser	SWP 031 01
Masking Procedures	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance silver plating on stainless steel or nickel.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Parts shall be fully submerged before electrical contact is made, and remain fully submerged until electrical contact is discontinued.	1 to 3	PS 211 or 223, 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201 anodic only 10 to 15 ASF * If parts are masked with wax, temperature shall not exceed 135°F (57°C)	120 to 210*	49 to 99*
3	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 316, 322 or SPS 26 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	a. Immerse in alkaline strip solution until all plate is removed. No current.	As reqd	PS 316, 322 or SPS 26	120 max	49 max
	b. (Alternate) Make anodic and agitate PS 310 strip solution.	As reqd	(Alternate) PS 310; anodic, 10 to 15 ASF Alternate: PS 11 without current at room temperature		
5	Clean water rinse.	0.5	Water	Room	Room
6	Remove any masking.	2 to 10	-	-	-
7	Cold water rinse.	0.5	Water	Room	Room
8	Hot water rinse.	0.5	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-
10	Preserve in oil if procedure not to continue immediately.	0.5 to 1.0	MIL-C-15074	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
11	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
12	Bake parts having a hardness of Rockwell C40 or higher, which have been repaired by grinding or machining.	120	-	290 to 310	140 to 154
13	Mask as necessary per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-
14	Alkali clean. Parts shall be fully submerged befor electrical contact is made, and remain fully submerged until electrical contact is discontinued.	1 to 3	PS 211 or 223 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201 anodic only 10 to 15 ASF *If parts are masked with wax, temperature shall not exceed 135°F (57°C).	120 to 210*	49 to 99*
15	Clean water rinse.	0.5	Water	Room	Room
16	a. Immerse in alkali solution to remove smut, using no current.	0.5	PS 211 or 223	110 to 130	43 to 54
	b. (Omit if smut was completely removed in step a.) Apply current.	1.0	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
	c. Clean water rinse	0.5	Water	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
16 (con't)	d. (Stainless Steel Parts Only) Immerse in acid etching solution. No current.	0.5 to 1.0	PS 53 Alternates: PS 25, 54 or 138	Room	Room
	e. (Nickel Alloy Parts Only) Immerse in acid etching solution. No current.	0.1 to 0.2	PS 48 Alternates: PS 38 or 222	Room	Room
17	Clean water rinse.	0.5	Water	Room	Room
18	Alkali clean. Parts shall be fully submerged before electrical contact is made, and remain fully submerged until electrical contact is discontinued.	1 to 3	PS 211 or 223, 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
19	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Ensure positive contact between fixture and part to prevent arcing.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
20	Immerse in etching solution.	0.5 to 1.0	PS 53 Alternates: PS 13, 25, 50, 54 without current; or PS 138, anodic 200 ASF.	Room	Room
21	Clean water rinse.	0.5	Water	Room	Room
22	Immerse in nickel strike solution. Current to be OFF when immersing or withdrawing parts.	4 to 6	PS 14; 35 to 75 ASF for 300 amper-minutes per square foot, minimum. EXAMPLE: 5 minutes at 60 ASF. NOTE Threaded parts required 400 to 500 ASF.	Room	Room
23	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 52 is a dilute caustic. Avoid contact.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
24	Immerse in neutralizing solution.	0.5 to 20	PS 52 Alternates: PS 101 or 201	Room	Room
25	Clean water rinse	0.5	Water	Room	Room

WARNING

PS 305 and 306 alkaline silver cyanide solutions are extremely poisonous. Ensure no personal contact. Use adequate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
26	Immerse in silver strike solution. Current to be OFF when immersing parts.	0.3 to 0.4	PS 305; 15 to 35 ASF	Room	Room
27	Immerse in silver plating solution. Current to be ON when immersing parts.	As reqd	PS 306 or 306 with PS 307; 10 to 25 ASF for exposed areas of parts and fixtures.	130 max	54 max
28	Clean water rinse.	0.5	Water	Room	Room
29	Remove any masking.	2 to 10	-	-	-
30	Remove stains from plated areas.	1 to 2	Pumice, Grade FFF; water	-	-
31	Cold water rinse.	0.5	Water	Room	Room
32	Remove excess plate, using step a., b., or c below. a. Using emery cloth or crocus cloth.	-	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
32 (cont'd)	b. Using a speed lathe or air gun with a wire brush, followed by emery cloth or crocus cloth. c. Using masking and chemical stripping per Operations 1 through 7.				
33	Hot water rinse.	0.5	Water	150 to 185	66 to 85
34	Preserve in oil if procedure not to continue immediately.	0.5 to 1.0	MIL-C-15074	Room	Room
35	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-

CAUTION

An inert atmosphere, such as nitrogen or argon, is required for the alternate high temperature bake.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
36	Bake.	120 20	- Alternate	375 to 425 940 to 960	191 to 218 504 to 505
37	Inspect plate and preserve as required.	1 to 20	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, NICKEL-CADMIUM (SPOP 25)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 24

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 23	0				
24 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Salt Spray Test	ASTM B117
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning, Carbon Solvent and Paint Stripper, Two Step (SPOP 7)	SWP 031 04
Cleaning, Alkaline Rust Remover, Long Soak (SPOP 203)	SWP 031 09
Masking Procedures (SPOP 36)	SWP 092 12
Stripping Nickel or Nickel-Cadmium Plate from Silver or Copper Alloy Brazed Parts (SPOP 40)	SWP 092 14
Stripping Nickel-Cadmium Plate With Preservation of Underlying Nickel Plate Repairs (SPOP 310)	SWP 092 29

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, denatured	O-E-760, Type III
Enamel, aluminum-silicone	DuPont Type 2, Formula 612-706 or Isis, Formula LB-304 or Pratt & Lambert Formula 7897, Type 1
Glass beads, 270 mesh	MIL-G-9954, size 13
Oil, corrosion preventive	MIL-C-15074
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.
(See Figure 1.)

a. This subordinate work package contains instructions for depot maintenance nickel-cadmium plating, test panel processing, and measurement of cadmium deposition rate.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

- Any underlying nickel plate repairs will be stripped by this procedure, and will then require complete removal and restoration before replating. Nickel-cadmium plate can be stripped without removal of underlying nickel plate repairs, by use of T.O. 2J-F100-53-1, SWP 092 29.
- Hardface coatings may be damaged or removed by this procedure, and shall be checked and restored as applicable prior to replating.
- For compressor disks or hubs, any carrying and handling fixtures shall be made of soft (annealed) stainless steel having a hardness of Rockwell C25 or less, or be covered with a soft material. Bare metal fixtures shall have well-rounded corners.
- Do not use this procedure for stripping nickel-cadmium plate from silver or copper alloy brazed parts. Refer to T.O. 2J-F100-53-1, SWP 092 14.

NOTE

- To ensure satisfactory plating results, test panels may be plated per paragraph 2, this SWP.
- Use P&WA approved fixture design when specified for particular part(s) per WP/SWP.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped per T.O. 2J-F100-53-1, SWP 092 12, and attach plating fixtures.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Parts shall be fully submerged before electrical contact is made, and remain fully submerged until electrical contact is discontinued.	1 to 3	PS 211 or 223, 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

NOTE

Parts requiring P&W approved fixture design shall be recleaned after relocating fixture attachment.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Cold water rinse.	0.5	Water	Room	Room
4	Examine for water breaks. If water breaks occur, scrub areas to be stripped using alkali solution and pumice; then rinse.	1 to 5	Pumice, Grade FFF PS 211 or 223 Alternates: PS 101 or PS 201	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

- PS 316, 322 and SPS 26 are strongly caustic and will burn skin and clothing. In addition, they contain cyanide which is extremely poisonous. Use appropriate protection.
- PS 644 does not contain cyanide, but is poisonous, and a strong oxidizer. Ensure that solution does not drip onto, then dry on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard. Vapor is irritating to eyes, nose, throat, and skin. Provide adequate ventilation and prevent personal contact, with appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Remove plating fixture and immerse in stripping solution.	As reqd	PS 316, 322 or SPS 26	120 max.	49 max.
			Alternate: PS 644 or strip nickel-cadmium per T.O. 2J-F100-53-1, SWP 092 14.	100 to 120	38 to 49
6	Clean water rinse.	0.5	Water	Room	Room
7	Check for complete removal of plate. If necessary, repeat Operations 4, 5, and 6.	-	-	-	-
8	Remove any masking.	2 to 10	-	-	-
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry.	1 to 3	Shop air	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
11	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
12	Restore nickel plate repairs as necessary, or nickel plate to dimensions as required by WP/SWP, before continuing with nickel-cadmium plating.	-	-	-	-
13	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
14	Bake parts having a hardness of Rockwell C40 or higher, which have been repaired by grinding or machining.	120	-	290 to 310	143 to 154

NOTE

Use P&W approved fixture design when specified for particular part(s) per WP/SWP.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
15	Mask as required per T.O. 2J-F100-53-1, SWP 092 12, and attach plating fixture.	As reqd	-	-	-
16	Alkali clean. Parts shall be fully submerged before electrical contact is made, and remain fully submerged until electrical contact is discontinued.	1 to 3	PS 211 or 223, 25 to 150 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
17	Clean water rinse.	0.5	Water	Room	Room
18	Examine for water breaks. If water breaks occur, scrub areas to be plated, using pumice and alkali solution.	1 to 3	Pumice, grade FFF PS 211 or PS 223 Alternates: PS 101 or PS 201	Room	Room
19	Clean water rinse.	0.5	Water	Room	Room
20	Repeat Operations 16 through 19.	-	-	-	-
21	Immerse in acid etching solution. No current.	0.8 (after gas-sing starts)	PS 53 Alternates: PS 13, 19, 25, 50, 54 or 138 or 3	Room 90 to 110	Room 32 to 43
22	Clean water rinse.	0.5	Water	Room	Room
23	(Stainless Steel Parts Only) Immerse in nickel strike solution.	4 to 6	PS 14; 35 to 75 ASF for 300 ampere-minutes per square foot, minimum. EXAMPLE: 5 minutes at 60 ASF.	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
24	Clean water rinse.	0.5	Water	Room	Room

NOTE

30 ASF deposits approximately 0.0003 inch of nickel in 12 minutes, except as follows:

1. When using blade plating fixture as specified in WP/SWP, 30 ASF deposits 0.0002 to 0.0004 inch nickel.

2. When compressor disk plating thickness is specified as 0.0004 to 0.0007 inch nickel, 30 ASF for 20 to 22 minutes meets this requirement. Refer to WP/SWP for specific requirements.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
25	Immerse in nickel plating solution. Current to be ON when immersing parts.	As reqd	PS 321; 30 ASF	115 to 130	46 to 54
26	Clean water rinse.	0.5	Water	Room	Room
27	Neutralize in alkali solution.	0.2 to 0.5	PS 52 Alternate: PS 101 or 201	Room	Room
28	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Inspect properly, then continue plating procedure without delay. Nickel plate could form a less active surface (passivate), and interfere with subsequent deposition of cadmium.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
29	a. Inspect nickel plate for complete coverage. Plate shall be firmly and continuously bonded to the basis metal and shall be smooth, uniform in appearance and free from frosty areas, pinholes, nodules, blisters, or any other defect.	1.0 to 2.0	-	-	-

NOTE

- The Magne-Gage can be obtained from the American Instrument Company, 8030 Georgia Avenue, Silver Spring, MD 20910.
- Since nickel is magnetic, calibrate instrument using a master panel having a magnetic coating of known thickness, on a magnetic basis material.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. Using a Magne-Gage, or equivalent, check thickness of plate. Unless otherwise specified in WP/SWP, thickness shall be 0.0002 to 0.0004 inch except in holes, grooves, or recesses, where 0.00005 inch thick is the minimum acceptable. Nickel buildup shall not exceed 0.002 inch thick in any area unless specified in WP/SWP for a particular part.	-	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
30	Alkali clean by immersion.	1 to 3	PS 101 or 201 Alternate: PS 117 *If parts are masked with wax, temperature shall not exceed 135°F (57°C).	120 to 210*	49 to 99*
31	Clean water rinse.	0.5	Water	Room	Room
32	Examine for water breaks. If water breaks occur, scrub areas to be plated, using pumice and alkali solution.	1 to 5	Pumice, Grade FFF PS 101 or 201 Alternate: PS 117	Room	Room
33	Immerse in acid etching solution. No current.	0.2 to 0.5	PS 53 Alternates: PS 13, 19, 25, 50, 54 or 130 or PS 3	Room 90 to 110	Room 32 to 43
34	Clean water rinse.	0.5	Water	Room	Room
35	Immerse in neutralizing solution.	0.2 to 0.5	PS 52 Alternates: PS 101 or 201	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
36	Clean water rinse.	0.5	Water	Room	Room

WARNING

PS 301 contains cyanide, and cadmium salts, both of which are extremely poisonous. Ensure no personal contact. Use adequate protection.

CAUTION

Thickness of cadmium deposition shall be limited to 0.0001 to 0.0002 inch regardless of thickness of underlying nickel plate. Excess cadmium could cause failure of exposed stressed steel parts if it became molten during a temperature excursion of any sort. Cadmium to authorized thickness diffuses into nickel during final bake, and is no longer in free state. Free cadmium melts at approximately 610°F (321°C).

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
37	a. Determine Cadmium Time (cadmium deposition rate) per paragraph 3, this subordinate work package.	As reqd	-	-	-
	b. Immerse in cadmium plating solution.	As reqd based on Cadmium Time	PS 301; 25 ASF	Room	Room

NOTE

Cavities where solutions could be trapped shall be thoroughly flushed.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
38	Clean water rinse. (First)	0.5	Water	Room	Room
39	Clean water rinse. (Second)	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
40	(Optional) Remove plating fixtures and mechanical masking, as applicable.	As reqd	-	-	-
41	Immerse in chromate conversion solution.	0.1 to 0.3	PS 36 or 56	85 to 95	29 to 35
42	Clean water rinse, then spray part over rinse tank with clean cold water.	0.5	Water	Room	Room
43	Remove any masking not previously removed.	1 to 10	-	-	-

CAUTION

Water hotter than 150°F (66°C) can damage the chromate conversion coating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
44	Clean warm water spray or dip rinse.	0.5	Water	120 to 140	49 to 60
45	Air dry.	1 to 3	Shop air	-	-
46	(Processing Option A - see figure 1.)				
	a. Inspect cadmium plate for proper coverage and possible defects such as blisters or bare spots.	As reqd	-	-	-

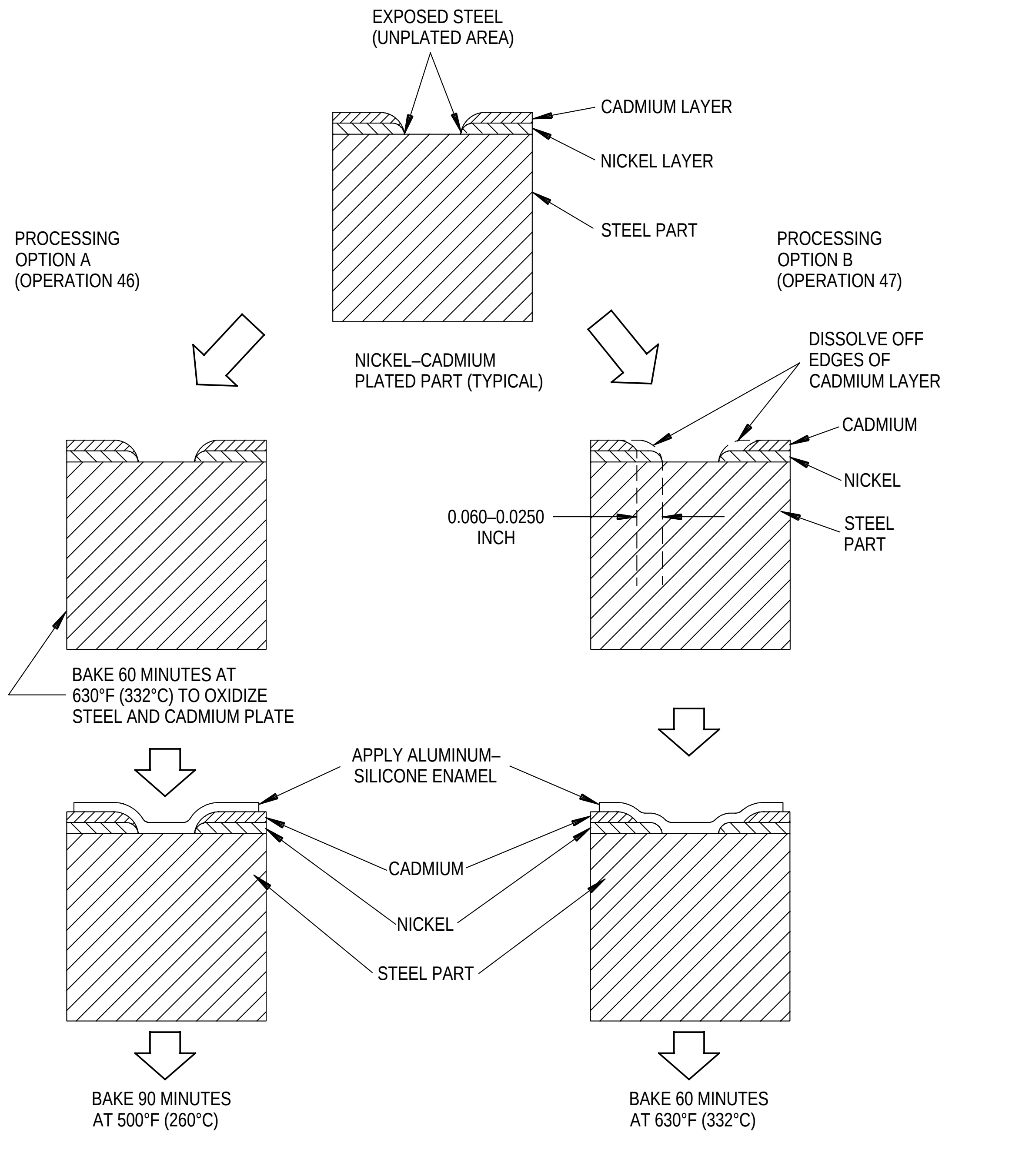


Figure 1. Protection of Unplated Areas on Nickel-Cadmium Plated Parts

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
46 (con't)					

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto, then dries on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

CAUTION

Do not substitute any other strip solution. Underlying nickel plate repairs could be damaged.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. If cadmium plate is not satisfactory, immerse in stripping solution (PS 590 only); rinse in clean water; then reprocess, starting from Operation 30.	As reqd	PS 590 Water	Room	Room
	c. Diffusion bake.	60 mini-mum	-	620 to 640	327 to 338
	d. Inspect diffused nickel-cadmium plate for following conditions: (1) Dull matte finish, smooth to touch. (2) Color varying from olive drab to black. (3) Absence of balling, blisters, nodules, pinholes, or pits when examined with a 3X magnifier.	As reqd	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
46 (con't)	e. If any defects, repeat this SWP from beginning.	-	-	-	-
	f. Brush or spray one coat of enamel on fixturing and electrical contact areas and any other unplated areas specified in WP/SWP.	As reqd	Enamel, aluminum-silicone	Room	Room
	g. Bake enamel.	90 mini-mum	-	475 to 525	246 to 274
47	(Processing Option B - see figure 1.)				
	a. Inspect cadmium plate for proper coverage and possible defects such as blisters or bare spots.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
47 (con't)					

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto, then dries on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

CAUTION

Do not substitute any other strip solution. Underlying nickel plate repairs could be damaged.

NOTE

Omit step 47.b. for compressor blades, tierods, or disks with windage tabs.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. Remove cadmium plate at boundaries adjacent to any unplated areas to be coated with enamel, to expose 0.060 to 0.250 inch of nickel plate. (See figure 1.) Swab cadmium to be removed, using a sharp-edged stick (tongue depressor) wrapped with a cloth moistened in strip solution.	As reqd	PS 590	Room	Room

CAUTION

Water hotter than 150°F (66°C) can damage the chromate conversion coating applied in Operation 41.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	c. Clean warm water spray or dip rinse.	0.5	Water	120 to 140	49 to 60

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
47 (con't)	d. Inspect cadmium plate for conformance to required configuration and dimensions per figure 1 and Operation 47.b.	As reqd	-	-	-
	e. If cadmium plate is not satisfactory, immerse in stripping solution; rinse in clean water; then reprocess, starting from Operation 30.	As reqd	PS 590 Water	Room	Room
	f. Brush or spray one coat of enamel on fixturing and electrical contact areas and any other unplated areas specified in WP/SWP.	As reqd	Enamel, aluminum-silicone	Room	Room
	g. Bake (for cadmium diffusion as well as curing enamel).	60 minimum	-	620 to 640	327 to 338
	h. Inspect diffused nickel-cadmium plate for following conditions:	As reqd	-	-	-
	(1) Dull matte finish, smooth to touch.				
	(2) Color varying from olive drab to black.				

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
47 (con't)	(3) Absence of balling, blisters, nodules, pinholes, or pits when examined with a 3X magnifier.				
	i. If any defects, repeat this SWP from beginning.	-	-	-	-

NOTE

Preservation is not required for parts plated all over.

48	Preserve in oil as required.	0.5	MIL-C-15074	Room	Room

2. PLATING TEST PANELS.

a. Nickel-cadmium plating procedure and solutions may be checked by plating test panels, before proceeding to plate parts. Repeat tests periodically as necessary to assure quality of plated parts.

b. Make or purchase panels of AMS 5040 or similar annealed carbon steel, 4 inches x 6 inches x 0.080 inch (approximate).

c. Prepare surface of one side of each of two test panels. Finished side only shall be used for evaluation. Reverse side shall be used for evaluation. Reverse side shall be permanently marked for identification. Grind or belt sand any surface imperfection which could prevent sound, continuous nickel plate. Do not blast with coarse abrasive. Surface roughness shall be preferably 25AA or lower.

d. Inspect finished panels using a 3X magnifier. Panels having pits, scratches, or gouges shall be rejected.

e. Check for magnetization as follows:

NOTE

A suitable instrument for indicating magnetization is the Field Strength Indicator, available from the Magnetic Analysis Corp., 535 South 4th Avenue, Mt. Vernon, NY 10553.

(1) Place indicator in contact with test panel with sides of meter adjacent to pivot end of pointer touching the panel.

(2) Move meter over all areas of test panel, watching needle of indicator during this procedure. Needle shall not deflect more than plus or minus one division of scale. If deflection is greater than plus or minus one division (±1 Gauss), test panel shall be demagnetized.

f. If necessary, demagnetize as follows:

(1) Pass test panel through entire length of demagnetizer.

(2) Hold test panel close to top or sides of demagnetizer.

(3) Withdraw test panel slowly.

(4) Remove test panel straight away from demagnetizer, and do not turn off current until test panel is at least three feet from demagnetizer.

(5) Repeat demagnetization test. If necessary, repeat procedure and test until satisfactory results have been obtained.

g. Immediately before plating, lightly wet glass bead blast using SPS 235. Refer to T.O. 2-1-111 for preparation and maintenance of glass bead slurry.

h. Plate test panels per this SWP, paragraph 1, Operations 15 through 47, and the following instructions:

(1) Attach nickel-cadmium test panel plating fixture coated except in contact area, at center of four inch end of panel, within 3/4 inch of edge.

(2) Plate 0.0002 to 0.0004 inch nickel in central area. Required current is approximately 30 ASF for 22 minutes.

(3) Inspect for nickel quality and thickness in central area.

(4) Plate 0.0001 to 0.0002 inch cadmium in central area. Required current is approximately 25 ASF for 1.25 times the standard Cadmium Time. Refer to this subordinate work package, Paragraph 3 for cadmium deposition rate.

(5) Inspect for cadmium quality in central area. Plate thickness may exceed 0.0004 inch nickel and 0.0002 inch cadmium in area within 0.75 inch from panel edges.

(6) Continue plating procedure through Operation 47.

i. Heat treat diffused test panels in circulating hot air over.

(1) Twenty-three hours at 690° to 710°F (366° to 377°C).

(2) One hour at 990° to 1010°F (532° to 543°C).

(3) There shall be no cracking or blistering of diffused nickel-cadmium plate on significant surfaces.

(4) Appearing of a loose, powdery film which can be easily wiped off is acceptable.

j. Test panels which satisfactorily pass heat resistance requirement in step i. shall be tested also for resistance to salt spray corrosion per ASTM B117 for 100 hours. One panel of the pair shall show no corrosion, and the second panel shall show no more than a few scattered corrosion spots.

3. CADMIUM DEPOSITION TIME.

(See Figure 2.)

a. Fabricate a test panel fixture similar to that shown in figure 2.

b. Fabricate test panels 2 x 3 x 0.050 inches, from copper sheet stock.

c. Clean test panels per T.O. 2J-F100-53-1, SWP 031 01 or 031 09; then scrub with pumice and water, using a plater’s tampico or nylon brush.

d. Rinse in water; then in O-A-51 acetone or O-E-760, Type III alcohol, and dry.

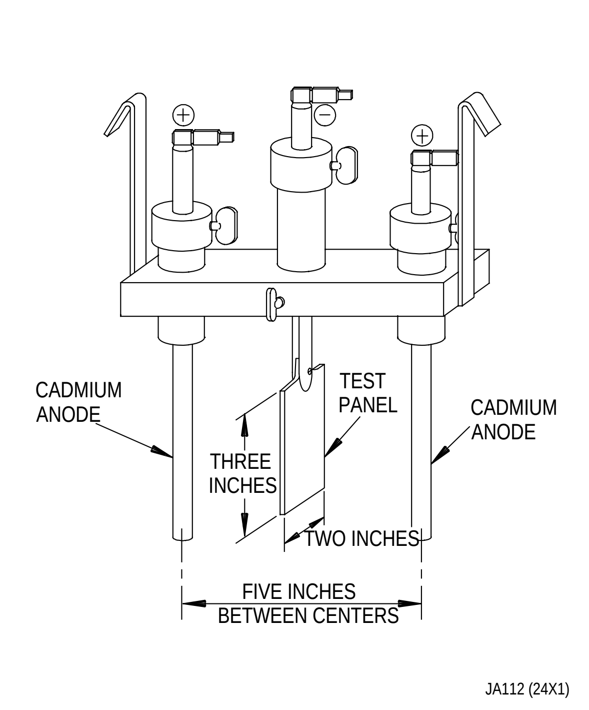


Figure 2. Test Panel Fixture for Determining Cadmium Time

e. Weight panel to nearest milligram. Record as Weight B.

f. Install panel in fixture, being careful not to touch surface to be plated.

WARNING

PS 301 contains cyanide, and cadmium salts, both of which are extremely poisonous. Ensure no personal contact. Use adequate protection.

g. Completely immerse fixtured test panel in PS 301 cadmium plating solution for which deposition rate is to be determined, at room temperature.

h. Check contacts for loose connections, and ensure that fixture is not grounded. Cadmium rods shall be used as anodes and test panel as cathode. Moderate stirring of solution is permitted.

i. Turn current ON at 2.1 amperes for three minutes; then turn current OFF.

j. Remove test panel. Rinse in water; then in acetone or alcohol, and dry.

k. Weight test panel to nearest milligram. Record as Weight A.

NOTE

The Deposition Rate or Cadmium Time is the time, in minutes and seconds, required to deposit 0.00015 inch of cadmium metal on test panel under conditions of this procedure.

l. Calculate Cadmium Time as follows:

Cadmium Time in minutes = $\frac{0.762,}{A-B}$
where:

A = weight of plated panel
B = original weight of panel

m. Test panels may be stripped in PS 590 and reused.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, NICKEL, ON STAINLESS STEEL, NICKEL, OR COBALT (SPOP 26)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12
Stripping Nickel or Nickel-Cadmium Plate from Silver or Copper Alloy Brazed Parts (SPOP 40)	SWP 092 14

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance nickel plating on stainless steel, nickel, or cobalt.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Careful masking is critical, since various materials are chemically attacked by stripping solutions in Operation 4. Hardface coatings may be damaged or removed by this procedure, and shall be checked and restored as applicable prior to replating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic	110 to 130	43 to 54
			Alternates: PS 101 or 201, anodic only; 10 to 15 ASF	120 to 210*	49 to 99*

*If parts are masked with wax, temperature shall not exceed 135°F (57°C).

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Clean water rinse.	0.5	Water	Room	Room

WARNING

- PS 316, 322 and SPS 26 contain cyanide which is extremely poisonous. Use appropriate protection.
- PS 644 does not contain cyanide, but is poisonous, and a strong oxidizer. Ensure that solution does not drip onto, then dry on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard. Vapor is irritating to eyes, nose, throat, and skin. Provide adequate ventilation and prevent personal contact, with appropriate protection.

CAUTION

- PS 11, 55, 316, 322, 644 or SPS 26 shall not be used for stripping nickel plate from silver or copper brazed parts. Refer to T.O. 2J-F100-53-1, SWP 092 14.
- Alternate stripping solutions PS 11 or PS 55 shall not be used on parts having a molybdenum content of 10% or higher, such as Hastelloy N, Hastelloy S, or Hastelloy W.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Immerse in stripping solution.	As reqd	PS 316, 322 or SPS 26	120 maximum	49 maximum
			Alternates: PS 11 or 55	Room	Room
			or PS 644	100 to 120	38 to 49
			or PS 325	125* to 175**	52* to 79**

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4 (con'd)			*Reduce solution to room temperature when not in use, to prolong life. **If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
5	Clean water rinse.	0.5	Water	Room	Room
6	Check for complete removal of plating.	-	-	-	-
7	Remove any masking.	2 to 10	-	-	-
8	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-
10	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
11	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5 to 1.0	MIL-C-15074	Room	Room
12	Bake parts having a hardness of Rockwell C40 or higher, which have been repaired by grinding or machining.	120	-	290 to 310	143 to 154
13	Mask as required per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-
14	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
15	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201, anodic only; 10 to 15 ASF.	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
16	Clean water rinse.	0.5	Water	Room	Room
17	a. Immerse in etching solution. Make part anodic.	1.0	PS 53; 60 ASF Alternates: PS 25, 54 or 138.	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
17 (con'd)					

NOTE

If this procedure is used, omit Operations 18 and 19.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. (Type 410 Stainless Steel Parts Being Finished with Nickel Plate)				
	Immerse in etching solution. No current.	2.0	PS 25, 53, 54 or 138 or PS3	Room 90 to 110	Room 32 to 43
18	Clean water rinse.	0.5	Water	Room	Room

CAUTION

Ensure thorough and complete smut removal from parts having molybdenum content 10% or higher, particularly Hastelloy W. Residual smut could cause low strength of plating bond.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19	a. Immerse in alkali solution to remove smut, using no current.	0.5	PS 211 or 223	110 to 130	43 to 54
	b. (Omit if smut was completely removed in step a.) Apply current.	1.0	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
	c. Clean water rinse.	0.5	Water	Room	Room
	d. (Stainless Steel Parts Only) Immerse in acid etching solution. No current.	0.5 to 1.0	PS 53 Alternates: PS 25, 54 or 138	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19 (con'd)	e. (Nickel or Cobalt Alloy Parts Only) Immerse in acid etching solution. No current.	0.1 to 0.2	PS 48 Alternates: PS 38 or 222	Room	Room
20	Clean water rinse.	0.5	Water	Room	Room
21	Immerse in nickel strike solution.	4 to 6	PS 14; 35 to 75 ASF for 300 ampere-minutes per square foot, minimum at 60 ASF.	Room	Room
22	Clean water rinse.	0.5	Water	Room	Room

NOTE

40 ASF deposits approximately 0.002 inch of nickel per hour.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
23	Immerse in nickel plating solution. Current to be ON when immersing parts.	As reqd	PS 321; 25 to 75 ASF	115 to 130	46 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
24	Clean water rinse.	0.5	Water	Room	Room
25	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
26	Air dry.	1.0	Shop air	-	-
27	Remove any masking.	2 to 10	-	-	-
28	Clean water rinse.	0.5	Water	Room	Room
29	Clean hot water rinse.		Water	150 to 185	66 to 85
30	Air dry.	1.0	Shop air	-	-
31	Inspect nickel plate	As reqd	-	-	-
32	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
33	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
34	a. Bake any parts cold worked after heat treat, or having a hardness of Rockwell C33 or higher.	180	-	365 to 385	185 to 196
	b. Bake any parts which would be adversely affected if baked at the preceding higher temperature.	300	-	290 to 310	143 to 154
35	Preserve in oil as required.	0.5	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

PLATING, NICKEL, ON STEEL (NOT STAINLESS) (SPOP 29)

EFFECTIVITY: ENGINE MODEL F100-PW-109

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12
Stripping Nickel or Nickel-Cadmium Plate from Silver or Copper Alloy Brazed Parts (SPOP 40)	SWP 092 14

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance nickel plating on steel (not stainless steel).

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Careful masking is critical, since various materials are chemically attacked by stripping solutions in Operation 4. Hardface coatings may be damaged or removed by this procedure, and shall be checked and restored as applicable prior to replating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201, anodic only; 10 to 15 ASF.	120 to 210*	49 to 99*

*If parts are masked with wax, temperature shall not exceed 135°F (57°C).

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Clean water rinse.	0.5	Water	Room	Room

WARNING

- PS 316, 322 and SPS 26 contain cyanide which is extremely poisonous. Use appropriate protection.
- PS 644 does not contain cyanide, but is poisonous, and a strong oxidizer. Ensure that solution does not drip onto, then dry on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard. Vapor is irritating to eyes, nose, throat, and skin. Provide adequate ventilation and prevent personal contact, with appropriate protection.

CAUTION

PS 316, 322, 644, or SPS 26 shall not be used for stripping nickel plate from silver or copper brazed parts. Refer to T.O. 2J-F100-53-1, SWP 092 14.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Immerse in stripping solution.	As reqd	PS 316, 322 or SPS 26	120 maximum	49 maximum
			or PS 644	100 to 120	38 to 49
			or PS 325	125* to 175**	52* to 79**
			*Reduce solution to room temperature when not in use, to prolong life. **If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
5	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	Check for complete removal of nickel plate.	-	-	-	-
7	Remove any masking.	2 to 10	-	-	-
8	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-
10	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
11	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
12	Bake parts having a hardness of Rockwell C40 or higher, which have been repaired by grinding or machining.	120	-	290 to 310	143 to 154
13	Mask as required per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	-	-	-
14	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
15	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201, anodic only; 10 to 15 ASF.	120 to 210*	49 to 99*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
16	Clean water rinse.	0.5	Water	Room	Room
17	Immerse in acid etching solution. Apply current.	2.0 to 2.5	PS 53 Anodic at 200 ASF minimum, followed by:	Room	Room
			Cathodic at 50 ASF minimum for 5 to 10 seconds.		
			Alternates: PS 13, 25, 50, 54 or 138 (at same current sequence as for PS 53).		

NOTE

If this procedure is used, omit Operations 18 and 19.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	(For Parts Finish Plated) No current.	0.8 after gasing starts	PS 13, 25, 50, 53, 54 or 138	Room	Room
			or PS 3	90 to 110	32 to 43

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
18	Clean water rinse.	0.5	Water	Room	Room
19	a. Alkali clean. Current to be OFF when immersing or withdrawing parts.	2 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
20	Clean water rinse.	0.5	Water	Room	Room
21	Immerse in acid etching solution. No current.	0.5 to 1.0	PS 53 Alternates: PS 13, 25, 50, 54 or 138.	Room	Room
22	Clean water rinse.	0.5	Water	Room	Room

NOTE

40 ASF deposits approximately 0.002 inch of nickel per hour.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
23	Immerse in nickel plating solution. Current to be ON when immersing parts.	As reqd	PS 321; 25 to 75 ASF	115 to 130	46 to 54
24	Clean water rinse.	0.5	Water	Room	Room
25	Immerse in neutralizing solution.	0.5 to 1.5	PS 52 Alternates: PS 101 or 201	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
26	Clean water rinse.	0.5	Water	Room	Room
27	Remove any masking.	2 to 10	-	-	-
28	Clean water rinse.	0.5	Water	Room	Room
29	Clean hot water rinse	0.5	Water	150 to 185	66 to 85
30	Air dry.	1.0	Shop air	-	-
31	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	Room	Room
32	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary	0.5	-	-	-
33	Bake any parts cold worked after heat treat, or having a hardness of Rockwell C33 or higher.	180	-	365 to 385	185 to 196
	Bake any parts which would be adversely affected if baked at the preceding higher temperature.	300	-	290 to 310	143 to 154
34	Preserve in oil as required.	0.5	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

MASKING PROCEDURES (SPOP 36)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Lacquer, stop-off	StanChem No. 66R-2866A or Miccromask stop-off lacquer
Maskant	Turcoform Maskant 505 or Turcoform Maskant 531
Pumice, Grade FFF	-
Tape, masking, cloth-backed	Tuck No. 90-W Red or F.O.S. No. 57-2 Red or Mystik No. 5863 Red or Kendall No. 222 or Kendall TB-30-113
Tape, masking, crepe-paper-backed	Norton No. 441 or 3M No. 2505 or Tuck No. 138 or Atmak PG-4 or Permacel No. 786
Tape, masking, lead foil	Scotch No. 421 lead foil tape
Tape, masking, plastic	Scotch No. 484 electroplating tape or Prata PC-165B
Tape, masking plastic, tapered	Microtape
Tape, masking, polyester (Mylar)	Mystik No. 7300 Mylar tape (white)
Tape, masking, zinc	Commercial zinc tape
Tetrachloroethylene (Perchlorethylene)	O-T-236
Wax, masking	Micro Wax C562 or Cerita 361B or Ross 64-0504

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance masking procedures.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.3., if necessary.	0.5	-	-	-

CAUTION

Ensure that an adequate electrical contact area is maintained when current is applied to a part for cleaning, stripping, or plating, in order to prevent possible burning.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Assemble part and plating fixture.	1 to 5	-	-	-
3	Install mechanical mask, if used.	1	-	-	-

CAUTION

Masking material shall be chosen according to surface bein protected, as well as composition and temperature of solution(s) to be withstood. Prevent accidental stripping or electroplate from areas of part other than the area to be cleaned, stripped, or plated.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Tape areas to be masked as required.	As reqd	Tape, masking	-	-
5	Apply lacquer or maskant to areas to be masked as required. Spray twice or brush on. Dry between coats.	2 to 5	Lacquer; maskant	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	Remove lacquer or maskant from areas to be plated.	3 to 5	Fine emery cloth or cloth moistened with O-T-236 tetrachloroethylene (perchlorethylene)	-	-
7	Wax areas to be masked as required, using two coats minimum	As reqd	Wax, masking	-	-
	(First coat of wax) Dip part in wax and allow to reach temperature of wax before removal, or heat part to about 250°F (121°C) before dipping.	As reqd	-	240 to 260	116 to 127
	(Second and subsequent coats of wax) Allow wax to set between coats, then dip in 180°F (82°C) wax.	As reqd	-	170 to 190	77 to 88
8	Trim wax with trimming blade, or with a sharp edged stick (tongue depressor) wrapped in a cloth moistened with degreasing solvent. This will produce a clean-cut edge, where necessary.	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	-	-
9	Scrub areas to be plated, using a cloth moistened with degreasing solvent	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	-	-
10	Scour areas to be plated, using a cloth and dry pumice.	As reqd	Pumice, Grade FFF	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

HARD COATING, ALUMINUM (AMS 2468) (SPOP 39)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance aluminum hard coating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

- Stripping this coating will reduce the basic aluminum alloy part dimension, because hard coating consists of approximately 50% buildup and 50% penetration. Do not use this process if it will result in a part with unacceptable dimensions.
- Parts composed of dissimilar alloys shall not be processed together.

NOTE

- Total coating thickness can be determined by physical measurements before and after hard coating. Buildup is equal approximately to one-half the total coating thickness. Coating thickness may be measured using an eddy current instrument, such as a Dermitron, manufactured by Unit Process Assemblies, Inc., 53-15 37th Avenue, Woodside, NY 11377.
- This procedure is intended primarily for hard coating aluminum alloys having less than 5% copper, less than 8% silicon, or less than 8% copper plus silicon.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped per T.O. 2J-F100-53-1, SWP 092 12, if necessary.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Immerse in acid stripping solution until all hard coating is removed.	As reqd	PS 488	165* to 185 *	74* to 85*
			*If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
3	Clean water rinse.	0.5	Water	Room	Room
4	Inspect for complete removal of hard coating. Coating is darker than basic metal of part. Repeat Operations 2, 3, and 4 as necessary.	As reqd	-	-	-
5	Remove masking, if used.	As reqd	-	-	-
6	Degrease. Refer to T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.	0.5	-	-	-
7	Mask as necessay. Refer to T.O. 2J-F100-53-1, SWP 092 12.	As reqd	-	-	-
8	Hard coat per AMS 2468, or continue operations.	-	-	-	-
9	Rack parts so there is positive electrical contact between parts and racks.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

- 36 amperes per square foot (ASF) provides a hard coating of approximately 0.002 inch thickness in 40 minutes.
- Air agitation of PS 487 is not recommended, since warmer air temperature would make it difficult to maintain low temperature of solution.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10	Immerse in well agitated aluminum hard coating solution. Establish positive electrical contact between rack and bus bar, making parts anodic.	As reqd	PS 487. Apply current, and bring amperage up to 36 ASF (or 0.25 amperes per square inch). Maintain current density by regulating voltage.	48 to 52	9 to 11
11	Break electrical circuit by opening switch, and remove parts from solution as promptly as possible.	-	-	-	-
12	Rinse in air-agitated running water. (First)	0.5	Water	Room	Room
13	Rinse in air-agitated running water. (Second)	0.5	Water	Room	Room
14	Air dry.	1 to 3	Shop air	-	-
15	Remove masking.	-	-	-	-
16	Degrease. Refer to T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
17	Inspect for adequate hard coating, uniformity, thickness, nicks, or scratches.				

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

STRIPPING NICKEL OR NICKEL-CADMIUM PLATE FROM SILVER OR COPPER ALLOY BRAZED PARTS (SPOP 40)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074
Pumice, Grade FFF	-
Tetrachloroethylene (Perchloroethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for Depot Maintenance stripping nickel or nickel-cadmium plate from silver or copper alloy brazed parts.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

P&W approved fixture design shall be used when specified by WP/SWP for particular part(s) for operations using electric current, to avoid possibility of damage to parts.

NOTE

This procedure also provides for possible preservation of underlying nickel plate repairs.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12. Attach required fixtures.	-	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts. **NOTE** Parts requiring P&W approved fixture design shall be recleaned after relocating fixture attachment.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Cold water rinse.	0.5	Water	Room	Room
4	Examine for water breaks. If water breaks occur, scrub areas to be stripped using alkali solution and pumice; then rinse.	1 to 5	Pumice, Grade FFF PS 211 or 223 Alternates: PS 101 or 201	Room	Room

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto, then dries on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	(All parts having nickel-cadmium plate)				
	a. Immerse nickel-cadmium plated parts in strip solution until all cadmium plate is removed.	As reqd	PS 590	Room	Room
	b. Cold water rinse.	0.5	Water	Room	Room

NOTE

Underlying nickel plate repairs may be preserved by appropriate masking. Nickel or nickel-cadmium plate may then be reapplied over repaired areas as well as the thin layer of nickel remaining from previous nickel-cadmium plating, after this subordinate work package has been completed.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	(For parts requiring preservation of underlying nickel plate repairs)				

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6 (con'd)	Mask nickel plate repaired areas, extending 0.030 inch minimum beyond entire repair boundaries. Apply maskant by brush in several coats to a thickness of 0.020 inch minimum, filling all voids, and providing protection for sharp edges.	As reqd	Maskant	Room	Room

CAUTION

Prevent contamination by cadmium of PS 325, or solution could become corrosive toward parts.

NOTE

Stripping time depends on thickness of plate and freshness of solution. Fresh solution will strip approximately 0.002 inch per hour at 175°F (79°C).

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
7	Immerse in mechanically agitated nickel strip solution.	As reqd	PS 325	125* to 175**	52* to 79**
			*Reduce solution to room temperature when not in use, to prolong life. **If parts are masked with wax, temperature shall not exceed 135°F (57°C).		
8	Cold water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 302 contains cyanide which is extremely poisonous. Ensure no personal contact. Provide adequate ventilation and use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
9	a. Immerse in cyanide cleaning solution. No current.	1 to 2	PS 302	Room	Room
	b. (Alternate to Operation 9.a.) Immerse in alkaline cyanide cleaner. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
10	Cold water rinse.	0.5	Water	Room	Room
11	Check for complete removal of nickel plate. If necessary, scrub with paste of pumice and water, then repeat Operations 6 through 11.	As reqd	Pumice, grade FFF Water	Room	Room
12	Rinse in clean hot water.	0.5	Water	150 to 185	66 to 85
13	Air dry.	1.0	Shop air	-	-
14	(For parts requiring preservation of underlying nickel plate repairs).Remove maskant by peeling off and/or immersing in heated degreasing solvent.	2 to 10	O-T-236 tetrachloroethylene (perchloroethylene)	248 to 256	120 to 124
15	Remove masking and fixtures.	2 to 10	-	-	-
16	Preserve in oil as required	0.5	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

CHROMATE CONVERSION, CHEMICAL, FOR MAGNESIUM (SPOP 41)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0				
8 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Crocus cloth	P-C-458
Tetrachloroethylene (Perchloroethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance chemical chromate conversion treatment for magnesium alloy parts. Both Touch-up (Method A) and Immersion (Method B) processes are included.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	Method A - Touch-up Process (continued)				
1	Clean with cloth moistened with degreasing solvent or with crocus cloth.	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	Room	Room
	NOTE Refer to T.O. 2-1-111 for solution preparation and maintenance.				
2	(Finished surfaces) a. Remove corrosion using brush or swab wet with hot chromic acid solution.	As reqd	SPS 24 (Discard after each use.)	180 to 325	82 to 163
	b. Cold water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
	Method A - Touch-up Process (continued)				
	c. Hot water rinse	0.5	Water	150 to 185	66 to 85
	d. Air dry	1 to 3	Shop air	-	-
	(Rough surfaces) Remove corrosion using wire brush or abrasive paper.	As reqd	-	-	-
3	Apply chromate conversion solution to surface with clean cloth. Repeat swabbing at frequent intervals throughout treatment to ensure area is wet with solution at all times.	*	PS 486	55 to 85	17 to 29
	*For AMS 4418 magnesium alloy, 2 to 3 minutes; for all other magnesium alloys, 0.5 to 0.75 minute.				
4	Thoroughly rinse touched-up area by swabbing several times with a clean cloth moistened in fresh portions of clean water.	As reqd	Water	Room	Room
5	Air dry	-	Shop air	-	-
6	Inspect for completeness of touch-up.	As reqd	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
		Method B - Immersion Process			

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	If necessary for removal of old conversion coating, immerse in stripping solution until coating is removed or mostly degraded (softened).	As reqd	PS 131	190 to 210	88 to 99
2	Clean water rinse or power wash, if necessary.	As reqd	Water	Room	Room
3	Scrub parts with fiber brush mechanically or by hand until all traces of surface coating are removed.	As reqd	Water	Room	Room
4	Clean water rinse.	1.0	Water	Room	Room
5	Degrease. Refer to T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.	0.5	-	-	-
6	Clean water rinse	0.5	Water	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
Method B - Immersion Process (continued)					
7	Immerse in chromic acid solution.	6 to 8	PS 484	Room	Room
8	Clean water rinse.	0.5	Water	Room	Room
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry.	1 to 3	Shop air	-	-
11	Check for cleanness.	As reqd	-	-	-
12	If necessary, repeat Operations 5, 9, and 10. Finish by cooling part to room temperature.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

Method B - Immersion Process (continued)

WARNING

PS 486 is strongly acidic, and will burn skin and clothing. Use adequate precautions including protection of hands with rubber gloves.

CAUTION

Ensure that handling time together with actual immersion time does not result in any area of any part remaining in contact with coating solution for more than 90 seconds.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
13	Immerse in chromate conversion solution.	1.0 maximum	PS 486	60 to 100	16 to 38
14	Rinse in air-agitated running water. (First)	0.5	Water	Room	Room
15	Rinse in air-agitated running water. (Second)	1.0 minimum	Water	Room	Room
16	Remove excess moisture from blind holes, if necessary.	As reqd	Shop air	-	-
17	Oven dry.	20 to 30	-	180 to 350	82 to 177
18	Inspect for uniformity of treatment.	-	-	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

ANODIZE TOUCH-UP, BRUSH OR SWAB (AMS 2473) (SPOP 42)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Crocus cloth	P-C-458
Tetrachloroethylene (Perchloroethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance anodize touch-up by brush or swab method.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Clean with cloth moistened with degreasing solvent or with crocus cloth.	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	Room	Room

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance. PS 607 container shall be marked with date of mixing, and discarded after 14 days.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
2	Swab or brush on anodize touch-up solution. Ensure that surface remains wet with solution throughout entire time of contact. NOTEIf solution fails to wet surface completely, remove with clean cloth and repeat Operations 1 and 2.	3 to 4	PS 607	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
3	Wipe with clean cloth moistened with clean water, or allow part to air dry.	As reqd	Water	Room	Room
4	Inspect for complete coverage, as indicated by brownish color.	As reqd	-	-	-
5	Blend touched-up area with a cloth to make entire coating as uniform as possible.	As reqd	-	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLATING, BARREL, NICKEL-CADMIUM (SPOP 49)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 12	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Plating, Nickel-Cadmium (SPOP 25)	SWP 092 09

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance nickel-cadmium plating by the barrel method.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

- Test panels may be processed as in T.O. 2J-F100-53-1, SWP 092 09, paragraph 2, using solutions intended for accomplishing this subordinate work package.
- Work load of hardware items to be plated shall be proportional to size of barrel. Provide quantity sufficient for adequate rotation of parts and good part-to-part electrical contact, but generally less than one-half volume of barrel.
- Barrel holes shall be as large as possible, but less than shank diameter of smallest (nonstainless) bolt or screw being plated. Otherwise, acceptable nickel plate thickness will not be obtained at specified voltage and time.
- Fabricate test slugs from cold-finished AISI 1018 or AISI 1020 machine steel, 3/8 inch thick and 1.0 inch diameter, with faces finished to roughness of 40 AA maximum. Slugs shall be free of corrosion.
- A rectifier with 15 to 20 volt capacity is required to deliver a nine volt range at cleaning and plating operations.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Load parts into plating barrel. Include two test slugs with load.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts.	3 to 5	PS 211 or 223 at 9 volts. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
3	Clean water rinse.	2 to 3	Water	Room	Room
4	Remove parts from barrel and load on trays.	2	-	-	-

WARNING

PS 316, 322 and SPS 26 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Immerse in stripping solution.	As reqd	PS 316, 322 or SPS 26	120 maximum	49 maximum
6	Clean water rinse.	2 to 3	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
7	Check for complete removal of old plate. If necessary, repeat Operations 4, 5, and 6.	As reqd	-	-	-
8	Clean hot water rinse.	1.0	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-
10	Preserve in oil if procedure not to continue immediately.	0.5	MIL-C-15074	-	-
11	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
12	Load parts into barrel.	2	-	-	-
13	Alkali clean. Current to be OFF when immersing or withdrawing parts.	3 to 5	PS 211 or 223 at nine volts. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
14	Clean water rinse.	2 to 3	Water	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
15	Immerse in acid etching solution. No current.	0.8 (after gassing starts)	PS 53 Alternates: PS 13, 19, 25, 50, 54 or 138 or PS3	Room 90 to 110	Room 32 to 43
16	Clean water rinse.	2 to 3	Water	Room	Room

NOTE

Nine volts deposits approximately 0.0002 to 0.0004 inch of nickel in 55 minutes.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
17	Immerse in nickel plating solution. Current to be ON when immersing parts.	55	PS 321 at nine volts	115 to 130	46 to 54
18	Clean water rinse	2 to 3	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19	Alkali rinse.	0.5 to 1.0	PS 52 Alternates: PS 101 or 201	Room	Room
20	Clean water rinse.	2 to 3	Water	Room	Room

CAUTION

Inspect promptly, then continue plating procedure without delay. Nickel plate could form a less active surface (passivate), and interfere with a subsequent deposition of cadmium.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
21	a. Unload parts and inspect plate for coverage. Plate shall be firmly and continuously bonded to the basis metal and shall be smooth, uniform in appearance and free from frosty areas, pinholes, nodules, blisters, or any other defect.	1.0 to 2.0	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
21 (cont'd)					

NOTE

- The Magne-Gage can be obtained from the American Instrument Co., 8030 Georgia Ave., Silver Spring, MD 20910.
- Since nickel is magnetic, calibrate instrument using a master panel having a magnetic coating of known thickness, on a magnetic basis material.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. Using a Magne-Gage, or equivalent, check thickness of plate. Unless otherwise specified in WP/SWP, thickness shall be 0.0002 to 0.0004 inch except in holes, grooves, or recesses, where 0.00005 inch thick is the minimum acceptable. Nickel buildup shall not exceed 0.002 inch thick in any area unless specified in WP/SWP for a particular part.	-	-	-	-

CAUTION

Do not use same barrel that was used for nickel plating.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
22	Load parts into plating barrel. Include two test slugs with work load.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
23	Alkali clean by immersion.	3 to 5	PS 101 or 201 Alternate: PS 117	120 to 130	49 to 54
24	Clean water rinse.	2 to 3	Water	Room	Room
25	Immerse in acid etching solution. No current.	0.5 to 1.0	PS 53 Alternates: PS 13, 19, 25, 50, 54 or 138 or PS3	Room 90 to 110	Room 32 to 43
26	Clean water rinse.	2 to 3	Water	Room	Room
27	Immerse in neutralizing solution.	0.5 to 1.0	PS 52 Alternates: PS 101 or 201	Room	Room
28	Clean water rinse.	2 to 3	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 301 contains cyanide and cadmium salts, both of which are extremely poisonous. Ensure no personal contact. Use adequate protection.

CAUTION

Thickness of cadmium deposition shall be limited to 0.0001 to 0.0002 inch regardless of thickness of underlying nickel plate. Excess cadmium could cause failure of exposed stressed steel parts if it became molten during a temperature excursion of any sort. Cadmium to authorized thickness diffuses into nickel during final bake, and is no longer in free state. Free cadmium melts at approximately 610°F (321°C).

NOTE

Nine volts deposits approximately 0.0001 to 0.0002 inch of cadmium in 15 minutes.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
29	Immerse in cadmium plating solution.	15	PS 301 at nine volts	Room	Room
30	Clean water rinse.	2 to 3	Water	Room	Room
31	Load parts on trays.	2	-	-	-
32	Clean water rinse.	2 to 3	Water	Room	Room
33	a. Using a Magne-Gage, or equivalent, check thickness of cadmium plate on test slugs, which shall be 0.0001 to 0.0002 inch.	-	-	-	-
	b. Inspect cadmium plate for proper coverage and possible defects such as blisters or bare spots.	-	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
33 (cont'd)					

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto, then dries on any combustible material, such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	c. If cadmium plate is not satisfactory, immerse in stripping solution; rinse in clean water; then reprocess, starting from Operation 23.	As reqd	PS 590 Water	Room	Room
34	Immerse in chromate conversion solution.	0.1 to 0.3	PS 36 or 56	85 to 95	29 to 35
35	Clean water rinse. (First)	2 to 3	Water	Room	Room
36	Clean water rinse. (Second)	2 to 3	Water	Room	Room

CAUTION

Water hotter than 150°F (66°C) can damage the chromate conversion coating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
37	Clean warm water spray or dip rinse.	1 to 2	Water	120 to 140	49 to 60

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
38	Air dry	1 to 3	Shop air	-	-
39	Diffusion bake.	60 minimum	-	620 to 640	327 to 338
40	Inspect the diffused nickel-cadmium plate for following conditions: a. Dull matte finish, smooth to touch. b. Color varying from olive drab to black. c. Absence of balling, blisters, nodules, pinholes, or pits when examined with a 3X magnifier. d. If any defects, repeat this SWP from beginning for affected parts.	As reqd	-	-	-
41	Preserve in oil as required, particularly parts having lockwire holes or deeply recessed heads.	0.5	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PLASMA SPRAY COATINGS WITH NITRIC ACID (SPOP 50)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of plasma spray coatings with nitric acid.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

CAUTION

- This procedure will strip or severely damage nickel, cadmium, or nickel-cadmium coatings on parts.
- Do not use this procedure on silver or copper brazed parts.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Degrease. Refer to T.O 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	Load or rack parts in suitable stainless steel baskets or fixtures.	-	-	-	-

NOTE

- Stripping rate is approximately 0.02 inch coating thickness per minute.
- Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
3	Immerse in stripping solution.	As reqd to strip coating	PS 11	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
4	Cold water rinse.	0.5	Water	Room	Room
5	Compressed-air/water spray rinse to remove black smut.	0.5 to 1.0	Shop air, Water	Room	Room
6	Inspect for complete removal of coating. Dark color indicates unstripped coating. If necessary, repeat Operations 3 through 6 until coating is completely stripped.	As reqd	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. PS 52 is a dilute caustic. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
7	Immerse in neutralizing solution.	0.2 to 0.5	PS 52 Alternates: PS 211 or 223	Room	Room
8	Clean water rinse.	0.5	Water	Room	Room
9	Hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry	1 to 3	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PLASMA SPRAY COATINGS WITH CAUSTIC SODA (SPOP 51)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of plasma spray coatings with caustic soda.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	Load or rack parts in suitable steel baskets or fixtures.	As reqd	-	-	-

CAUTION

Do not use this solution for any other stripping procedure. Contamination can cause solution to become corrosive.

NOTE

- Stripping rate is approximately 0.035 inch coating thickness per hour at 100°F (38°C).
- Refer to T.O. 2-1-111 for solution preparation and maintenance.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
3	Immerse in stripping solution.	As reqd to strip coating	PS 209	Room to 100	Room to 38
4	Cold water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	Compressed-air/water spray rinse to remove black smut.	0.5 to 1.0	Shop air, Water	Room	Room
6	Immerse in stripping solution to check for complete coating removal. If no black smut forms, repeat Operations 3 through 6 until coating is completely stripped.	5	PS 209	Room to 100	Room to 38
7	Cold water rinse.	0.5	Water	Room	Room
8	Hot water rinse.	0.5	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PLASMA SPRAY COATINGS WITH NICKEL STRIP SOLUTION (SPOP 53)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures - - - - - - - - - - - - - - - - -	T.O. 2-1-111
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3) - - - - - - - - - - - - - - -	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of plasma spray coatings with nickel strip solution.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

CAUTION

This procedure will strip or severely damage nickel, cadmium or nickel-cadmium coatings on parts.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Degrease. Refer to T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	Load or rack parts in suitable stainless steel baskets or fixtures.	As reqd	-	-	-

NOTE

- Refer to T.O. 2-1-111 for solution preparation and maintenance.
- Stripping rate is approximately 0.005 inch coating thickness per hour at 150°F (66°C).

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
3	Immerse in stripping solution.	As reqd to strip coating	PS 325	140 to 160	60 to 71
4	Cold water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	Compressed-air/water spray rinse to remove black smut.	0.5 to 1.0	Shop air, Water	Room	Room
6	Inspect for complete removal of coating. Dark color indicates unstripped coating. If necessary, repeat Operations 3 through 6 until coating is completely stripped.	As reqd	-	-	-
7	Hot water rinse.	0.5	Water	150 to 185	66 to 85
8	Air dry.	1	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PWA 47, PWA 73, OR PWA 273 ALUMINIDE COATING FROM PWA 655, PWA 656, PWA 663, PWA 1422, OR PWA 1455 PARTS WITH NITRIC-PHOSPHORIC ACID (SPOP 54)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0				
8 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Grit, aluminum oxide, SAE grain size 240	Aloxite 240 WPM or Norton Alundum 240 E1B
Grit, aluminum oxide, SAE grain size 320	Norton Alundum 320 E1B or Exolon Polishing Grain RHT
Tetrachloroethylene (Perchlorethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordiante work package contains instructions for depot maintenance stripping of PWA 47, PWA 73, or PWA 273 aluminide coating from PWA 655, PWA 656, PWA 663, PWA 1422, or PWA 1455 parts with nitric-phosphoric acid.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Degrease per T.O. 2J-F100-53-1 SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	Mask carefully areas not to be stripped, to prevent overspray damage.	As reqd	Mechanical masks, or sufficient layers of tape	-	-
3	Dry grit blast areas to be stripped.	As reqd	Grit, aluminum oxide, No. 240 or No. 320 at 30 psi (pressure-type machine), or at 75 psi (suction-type machine). Maximum dwell time is 20 seconds.	-	-
4	Remove masking.	-	-	-	-
5	Wax mask all uncoated areas, and any coated areas not to be stripped, per T.O. 2J-F100-53-1, SWP 092 12.	As reqd	-	-	-
6	Load or rack parts in suitable baskets or fixtures composed of (or coated with) polyethylene or polypropylene.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

SPS 36 and 37 are strongly acidic, and will burn skin and clothing. In addition, SPS 37 contains fluoride salts which are poisonous. Use appropriate protection.

CAUTION

- Vigorous agitation is required to prevent local pitting.
- Ensure that masking is fully intact immediately before immersing.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
7	Immerse in acid stripping solution.	30	SPS 36 or 37	Room 75 minimum	Room 24 minimum
8	Rinse thoroughly in clean, cold water	0.5	Water	Room	Room
9	Rinse thoroughly in clean, warm water	0.5	Water	135 maximum	57 maximum
10	Air dry.	1.0	Shop air	-	-
11	Mask to prevent overspary damage.	As reqd	-	-	-
12	Dry grit blast areas to be stripped.	As reqd	Grit, aluminum oxide, No. 240 or No. 320 at 30 psi (pressure-type machine), or at 75 psi (suction-type machine). Maximum dwell time is 20 seconds.		

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
13	Cold water rinse.	0.5	Water	Room	Room
14	Compressed air/water spray rinse.	0.5 to 1.0	Water, shop air	Room	Room
15	Repeat Operations 7 through 14, three additional times. Total acid immersion time is now 2 hours.	As reqd	-	-	-

WARNING

SPS 36 and 37 are strongly acidic, and will burn skin and clothing. In addition, SPS 37 contains fluoride salts which are poisonous. Use appropriate protection.

CAUTION

- Vigorous agitation is required to prevent local pitting.
- Ensure that masking is fully intact immediately before immersing.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
16	Immerse in acid stripping solution.	5	SPS 36 or 37	Room (75 min)	Room (24 min)
17	Cold water rinse.	0.5	Water	Room	Room
18	Check for smut on surface. If absent, proceed directly to Operation 31. If smut is present, continue Operations.	As reqd	-	-	-

CAUTION

- Vigorous agitation is required to prevent local pitting.
- Ensure that masking is fully intact immediately before immersing.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
19	Immerse in acid stripping soluiton.	25	SPS 36 or 37	Room (75 min)	Room (24 min)
20	Rinse thoroughly in clean cold water.	0.5	Water	Room	Room
21	Rinse thoroughly in clean warm water.	0.5	Water	135 maximum	57 maximum
22	Air dry.	1.0	Shop air	-	-
23	Mask to prevent overspray damage.	As reqd	-	-	-
24	Dry grit blast areas to be stripped.	As reqd	Grit, aluminum oxide, No. 240 or No. 320 at 30 psi (pressure-type machine), or at 75 psi (suction-type machine). Maximum dwell time is 20 seconds.	-	-
25	Cold water rinse.	0.5	Water	Room	Room
26	Compressed-air/water spray	0.5 to 1.0	Water, Shop air	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

- Vigorous agitation is required to prevent local pitting.
- Ensure that masking is fully intact immediately before immersing.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
27	Immerse in acid stripping solution.	5	SPS 36 or 37	Room (75 minimum	Room (24 minimum
28	Cold water rinse.	0.5	Water	Room	Room
29	Check for smut on surface. If absent, proceed directly to Operation 31. If smut is present, continue Operations.	As reqd	-	-	-

CAUTION

Total immersion time in acid solution shall not exceed seven hours.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
30	Repeat Operations 19 through 29 until coating has been removed, or until acid immersion limit of seven hours has been reached.	As reqd	-	-	-
31	Remove mechanical masking or tape, if used, and strip all masking wax in hot degreasing solvent.	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	248 to 256	120 to 124

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - ACCELERATED STRIPPING NICKEL-CADMIUM PLATE FROM MARTENSITIC STAINLESS STEEL COMPRESSOR BLADES WITH ACID (SPOP 56)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Oil, corrosion preventive	MIL-C-15074
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance accelerated acid stripping of nickel-cadmium plate from martensitic stainless steel compressor blades.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

CAUTION

This procedure is limited to the stripping of martensitic stainless steel compressor blades.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Alkali clean. No current.	1 to 2	PS 211 or 223 Alternate: PS 101	110 to 130	43 to 54
2	Cold water rinse.	0.5	Water	Room	Room

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Examine for water breaks. If water breaks occur, scrub areas to be stripped using alkali solution and pumice.	1 to 5	Pumice, grade FFF PS 211, 223 Alternate: PS 101	Room	Room
4	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Air dry.	1.0	Shop air	-	-
6	Immerse parts in acid stripping solution.	5 maximum	SPS 28	Room	Room
7	Clean cold water rinse.	0.5	Water	Room	Room

CAUTION

Cycle may be repeated once or twice only. Total part immersion time in stripping solution shall not exceed 15 minutes.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
8	Check for complete removal of nickel-cadmium plate. If stripping is not complete, scrub with paste of pumice and water; rinse; then repeat entire procedure beginning with Operation 1.	As reqd	Pumice, Grade FFF Water	Room	Room
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry.	1.0	Shop air	-	-
11	Preserve in oil as required.	0.5	MIL-C-15074	Room	Room

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - CLEANING TITANIUM WITH ACID (SPOP 302)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work pakage contains instructions for depot maintenance acid cleaning of titanium.

CAUTION

- Use this procedure only when specified in WP/SWP. Primary application is for cleaning preparation of certain titanium parts for electron beam welding. Incorrect use of this procedure could result in irreparable part damage.
- All water rinses shall have a chloride content not to exceed 10 ppm.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Alkali clean. No current.	0.5	PS 101	170 to 190	77 to 88
2	Clean water rinse.	0.5	Water	Room	Room
3	Compressed-air/water spray rinse.	0.5 to 1.0	Shop air, Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Immerse in acid cleaning solution.	1 to 5	PS 222	60 to 90	16 to 32

CAUTION

- Transfer part as quickly as possible from acid cleaning tank to rinse tank, or staining may result.
- Do not use same rinse tank that has been used for rinsing after alkali cleaning.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Clean water rinse.	0.5	Water	Room	Room
6	Check for complete removal of oxide scale and stain. If cleaning is not complete, procedure may be repeated once only, beginning with Operation 4.	As reqd	-	-	-
7	Compressed-air/water spray rinse entire surface of part.	0.5 to 1.0	Shop air, Water	Room	Room
8	Clean hot water rinse.	0.5 to 1.0	Water	150 to 185	66 to 85
9	Air dry.	1 to 3	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PLASMA COATINGS WITH NITRIC-SULFURIC ACID (SPOP 304)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of plasma spray coatings with nitric-sulfuric acid.

Plasma Coatings With Nitric-Sulfuric Acid

CAUTION

- All inserts, weights, or other detachable metallic components shall be removed from titanium assemblies before stripping.
- All water rinses shall have a chloride content not to exceed 10 ppm.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Alkali clean. No current.	1 to 2	PS 101	Room to 190	Room to 88
2	Cold water rinse.	0.5	Water	Room	Room
3	Immerse in acid stripping solution until gassing is finished. Coating removal should then be complete.	As reqd	SPS 33	Room	Room
4	Cold water rinse.	0.5	Water	Room	Room

Plasma Coatings With Nitric-Sulfuric Acid (continued)

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Immerse in alkaline neutralizing solution.	0.5 to 1.5	PS 52 Alternate: PS 101 or 201	Room to 190	Room to 88
6	Cold water rinse.	0.5	Water	Room	Room
7	Hot water rinse.	0.5	Water	150 to 185	66 to 85
8	Air dry.	1.0	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING SILVER OR COPPER BRAZING ALLOY FROM CORROSION AND HEAT RESISTANT STEEL (SPOP 305)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Glass beads, 230 mesh	MIL-G-9954, size 13

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of silver or copper brazing alloy from corrosion and heat resistant steel.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

If nickel-cadmium plate is present on part, it shall be stripped before using this stripping procedure. Refer to SWP 092 19.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Degrease. Refer to SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	If required, wax mask areas not to be stripped. Refer to SWP 092 12.	As reqd	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3 (cont.)			Alternates: PS 101 or 201, anodic only; 25 to 35 ASF. *If parts are masked with wax, temperature shall not exceed 135°F (57°C).	120 to 210*	49 to 99*
4	Cold water rinse.	0.5	Water	Room	Room

NOTE

Time in acid to strip braze may require 4 to 20 hours. Momentary withdrawal from solution once an hour will speed up stripping action.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Immerse in acid stripping solution.	As reqd	PS 55 Alternate: PS 11	Room	Room

CAUTION

Parts shall not be allowed to become dry during transfer to rinse tank.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	Cold water rinse.	0.5	Water	Room	Room
7	Compressed-air/water spray rinse to remove smut and foreign material.	0.5 to 1.0	Shop air; Hot tap water	150 to 185	66 to 85
8	Inspect for complete removal of braze. If necessary, repeat Operations 5 through 8.	As reqd	-	-	-

NOTE

Operations 9 through 11 may be omitted if part is not to be rebrazed.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
9	Wet or dry glass bead blast stripped areas as necessary, to remove all residues of smut and foreign material.	As reqd	SPS 235 glass bead slurry. (Refer to T.O. 2-1-111 for slurry preparation and maintenance.) Dry glass beads, 270 mesh; MIL-G-9954, size 13	Room	Room
10	Compressed-air/water spray rinse to remove all traces of glass beads.	0.5 to 1.0	Shop air; Hot tap water	150 to 185	66 to 85
11	Inspect for complete removal of braze using a 10X magnifier. If necessary, repeat Operations 5 through 11.	As reqd	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
12	Immerse in alkaline neutralizing solution.	0.2 to 0.5	PS 52 Alternates: PS 101, 211, or 223	Room	Room
13	Remove masking, if used.	As reqd	-	-	-
14	Clean cold water rinse.	0.5	Water	Room	Room
15	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
16	Air dry.	1.0	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PWA 77 ALUMINIDE COATING (SPOP 307)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Hydrochloric acid, concentrated	O-H-765
Hydrochloric acid, inhibited	Pennwalt PM-90
Inhibitor for muriatic acid	Rodine XL1090A

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of PWA 77 aluminide coating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

CAUTION

All fillers, dampening, or stiffening material shall be removed before using this procedure.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Degrease. Refer to T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
2	Soak in alkaline permanganate solution.	15 to 1440 (24 hours)	PS 227	180 to 200	82 to 93
3	Pressure rinse over permanganate tank, then dip rinse in separate tank.	2 to 3	Water	Room	Room
4	Wax mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

NOTE

Hydrochloric acid may be purchased ready to use (full strength); or, concentrated hydrochloric acid may be purchased locally, and 0.5% by volume Rodine XL1090A (Inhibitor) added to the acid. Maintain operating level by adding acid and inhibitor in ratio of 200 to 1.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
5	Immerse in acid.	15	Inhibited hydrochloric acid	Room to 130	Room to 58
6	Cold water rinse.	0.5	Water	Room	Room
7	Check for complete removal. If coating is not completely removed, repeat Operations 5 through 7, as necessary.	As reqd	-	-	-
8	Immerse in alkaline neutralizing solution.	0.5 to 1.5	PS 52 Alternates: PS 101 or 201	Room Room to 190	Room Room to 88
9	Hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry.	1.0	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING PWA 26, PWA 27, PWA 45, PWA 47, PWA 63, PWA 73, OR PWA 273 ALUMINIDE COATING FROM PWA 647, PWA 652, PWA 653, PWA 654, PWA 655, PWA 656, PWA 657, PWA 658, PWA 663, PWA 664, PWA 1038, PWA 1066, PWA 1422, PWA 1451, PWA 1455, OR PWA 1456 PARTS WITH NITRIC ACID (SPOP 308)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Grit, aluminum oxide, SAE grain size 240	Aloxite 240 WPM or Norton Alundum 240 E1B
Grit, aluminum oxide, SAE grain size 320	Norton Alundum 320 E18 or Polishing Grain RHT
Tetrachloroethylene (Perchlorethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stripping of PWA 26, PWA 27, PWA 45, PWA 47, PWA 63, PWA 73 or PWA 273 aluminide coating from PWA 647, PWA 652, PWA 653, PWA 654, PWA 655, PWA 656, PWA 657, PWA 658, PWA 663, PWA 664, PWA 1038, PWA 1066, PWA 1422, PWA 1451, PWA 1455, or PWA 1456 parts with nitric acid.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
1	Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.	0.5	-	-	-
2	Mask carefully areas not to be stripped, to prevent overspray damage.	As reqd	Mechanical masks, or sufficient layers of tape.	-	-
3	Dry grit blast areas to be stripped.	As reqd	Grit, aluminum oxide, No. 240 or No. 320 at 30 psi (pressure-type machine), or at 75 psi (suction-type machine). Maximum dwell time is 20 seconds.	-	-
4	Remove masking.	-	-	-	-
5	Wax mask all uncoated areas and any coated areas not to be stripped, per T.O. 2J-F100-53-1, SWP 092 12.	As reqd	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
6	Load or rack parts in suitable baskets or fixtures composed of (or coated with) polyethylene or polypropylene.	As reqd	-	-	-

WARNING

PS 126 is a strong acid, and will burn skin and clothing. Use appropriate protection.

CAUTION

- Vigorous agitation is required to prevent local pitting.
- Ensure that masking is fully intact immediately before immersing.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
7	Immerse in acid stripping solution.	180	PS 126	75 to 90	24 to 32
8	Rinse thoroughly in clean, cold water.	0.5	Water	Room	Room
9	Compressed-air/water spray rinse.	0.5 to 1.0	Shop air; Water	Room	Room
10	Air dry.	1.0	Shop air	-	-
11	Mask to prevent overspray damage.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C

NOTE

Avoid blasting wax masked surfaces.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
12	Wet glass bead blast to remove smut.	As reqd	SPS 235 glass bead slurry	Room	Room
13	Rinse thoroughly in clean, cold water.	0.5	Water	Room	Room
14	Compressed-air/water spray rinse to remove all traces of glass beads.	0.5 to 1.0	Shop air; Water	Room	Room
15	Immerse in vigorously agitated acid.	5	PS 126	75 to 90	24 to 32
16	Check for complete removal of coating. If coating is absent (no dark, gray smut), proceed to Operation 19. If coating remains, continue Operations.	As reqd	-	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
17	Immerse in vigorously agitated acid.	55	PS 126	75 to 90	24 to 32
18	Repeat Operations 8 through 16, and, if necessary, Operation 17. **NOTE** No further immersion in acid stripping solution is permitted. The five hour maximum immersion limit has been reached.	As reqd	-	-	-
19	Rinse thoroughly in clean, cold water.	0.5	Water	Room	Room

NOTE

Ensure complete removal of all wax from internal passages.

Operation No.	Description of Operation	Time Mins	Solutions, Materials	Temp °F	Temp °C
20	Remove mechanical masking and tape, if used, and strip all masking wax in hot degreasing solvent.	As reqd	O-T-236 Tetrachloroethylene (Perchlorethylene)	248 to 256	120 to 124
21	Clean cold water rinse.	0.5	Water	Room	Room
22	Rinse thoroughly in clean hot water.	0.5	Water	150 to 185	66 to 85
23	Air dry.	1.0	Shop air	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLATING, ELECTROLESS NICKEL (SPOP 309)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0				
8 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Masking Procedures (SPOP 36)	SWP 092 12

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Maskant	Turcoform 505 or Turcoform 531
Pumice, Grade FFF	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance electroless nickel plating.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Circumstances when this procedure may be used:

1. For depositing nickel as the brazing alloy for joining PWA 24 corrosion and heat resistant alloy fiber metal sheet to AMS 5627 (430 S.S.) or AMS 5665 (Inconel 600) parts, when specified by WP/SWP.

2. For depositing nickel on AMS 5671 (Inconel X-750) parts, when specified by WP/SWP.

3. When AMS 2404 (electroless nickel plating) is specified by repair procedure in WP/SWP.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask as required, using maskant per T.O. 2J-F100-53-1, SWP 092 12.	5 to 20	Turcoform Maskant 505 or Turcoform Maskant 531	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	(Surface preparation for plating AMS 5627 (430 S.S.) parts)				
	a. Alkali clean. No current.	1 to 3	PS 211 or 223 Alternates: PS 101 or 201	110 to 130	43 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2 (cont)	b. Clean water rinse.	0.5	Water	Room	Room
	c. Examine for water breaks. If water breaks occur, scrub areas to be plated using alkali solution and pumice; then rinse in clean, cold water.	1 to 4	Pumice, grade FFF Water PS 211 or 223 Alternates: PS 101 or 210	Room	Room
	d. Repeat steps 2.a., 2.b., and 2.c.	As reqd	-	-	-
	e. Immerse in acid etching solution.	0.8 (after gassing starts)	PS 53 Alternates: PS 13, 19, 25, 50, 54 or 138	Room	Room
			or PS3	90 to 110	32 to 43

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	(Surface preparation for plating AMS 5665 (Inconel 600) or AMS 5671 (Inconel X-750) parts).				
	a. Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
			Alternates: PS 101 or 201; 10 to 15 ASF. Anodic only.	120 to 210	49 to 99
	b. Clean water rinse.	0.5	Water	Room	Room
	c. Immerse in acid etching solution. Apply current.	1.0	PS 53; 60 ASF. Anodic only. Alternates: PS 25, 54, or 138.	Room	Room
	d. Clean water rinse.	0.5	Water	Room	Room
	e. Alkali clean to remove smut. No current.	0.5	PW 211 or 223	110 to 130	43 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3 (cont)	f. (Omit if smut was completely removed in step 3.e.) Apply current.	1.0	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
	g. Clean water rinse.	0.5	Water	Room	Room
	h. Immerse in acid etching solution.	0.1 to 0.2	PS 48 Alternates: PS 38 or 222	Room	Room
4	Clean water rinse.	0.5	Water	Room	Room
5	Nickel strike.	4 to 6	PS 14; 35 to 75 ASF for 300 ampere-minutes per square foot (ASF), minimum. EXAMPLE: Five minutes at 60 ASF.	Room	Room
6	Clean water rinse.	0.5	Water	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

To estimate required time, include test panels periodically and measure thickness of nickel, to predict rate of deposition. Factors which affect rate are degree of agitation, and temperature of solution. Deposition rate under average conditions as specified is approximately 0.0004 inch per hour.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
7	Immerse in electroless nickel plating solution. If necessary, make cathodic and apply one volt to activate. Discontinue current as soon as gassing begins.	As reqd	PS 218	180 to 210	82 to 99
8	Clean cold water rinse.	0.5	Water	Room	Room
9	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
10	Air dry.	1.0	Shop air	-	-
11	Remove any masking.	2 to 10	-	-	-
12	Inspect nickel plate.	-	-	-	-

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - STRIPPING NICKEL-CADMIUM PLATE WITH PRESERVATION OF UNDERLYING NICKEL PLATE REPAIRS (SPOP 310)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 10	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Standard Maintenance Procedures	- - - - - - - - - - - - - - - - -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Hydrochloric (muriatic) acid, concentrated	O-H-765
Inhibitor for muriatic acid	Rodine XL1090A
Maskant	Turcoform Maskant 505 or Turcoform Maskant 531
Pumice, Grade FFF	-
Tetrachloroethylene (Perchloroethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION

a. This subordinate work package contains instructions for depot maintenance stripping of nickel-cadmium plate while preserving underlying nickel plate repairs (Method A or Method B).

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

NOTE

- In Method A, nickel plate repaired areas are masked and nickel-cadmium plate stripped in one operation. Cadmium remaining under masking is stripped after removal of masking.
- In Method B, cadmium layer is first stripped, then repaired areas masked, and finally nickel layer of nickel-cadmium plate is removed.
- In either Method A or Method B, a thin layer of nickel will remain from the old nickel-cadmium plate, over nickel plate repaired areas. This is acceptable, and nickel or nickel-cadmium plate can be reapplied over these areas.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	METHOD A				
1	Mask nickel plate repaired areas, extending 0.030 inch minimum beyond entire repair boundaries. Apply maskant by brush in several coats to a thickness of 0.020 inch minimum, filling all voids and providing protection for sharp edges.	As reqd	Maskant	Room	Room
2	Attach electrical fixtures.	As reqd	-	-	-

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

Refer to T.O. 2-1-111 for solution preparation and maintenance.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

NOTE

Parts requiring P&W approved fixture design shall be recleaned after relocating fixture attachment.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Cold water rinse.	0.5	Water	Room	Room

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Examine for water breaks. If water breaks occur, scrub areas to be stripped using alkali solution and pumice; then rinse.	1 to 5	Pumice, grade FFF; PS 211 or 223 Alternates: PS 101 or 201	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

- PS 316 and 322, or SPS 26 are strongly caustic and will burn skin and contain cyanide which is extremely poisonous. Use appropriate protection.
- PS 644 does not contain cyanide, but is poisonous and a strong oxidizer. Ensure that solution does not drip onto and then dry on any combustible material such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard. Vapor is irritating to eyes, nose, throat, and skin. Provide adequate ventilation and prevent personal contact, with appropriate protection.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
6	Remove plating fixtures and immerse in stripping solution.	As reqd	PS 316, 322 or SPS 26 Alternate: PS 644	120 maximum 100 to 120	49 maximum 38 to 49
7	Clean water rinse.	0.5	Water	Room	Room
8	Check for complete removal of nickel-cadmium plate. If necessary, repeat Operations 5, 6, and 7.	As reqd	-	-	-
9	Remove masking by peeling off or immersion in hot degreasing solvent.	2 to 10	O-T-236 tetrachloroethylene (perchloroethylene)	248 to 256	120 to 124

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto and then dries on any combustible material such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

NOTE

Concentrated hydrochloric (muriatic) acid may be purchased locally, and 0.5% by volume Rodine XL1090A (Inhibitor) added to the acid. Maintain operating level by adding acid and inhibitor in ratio of 200 to 1.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10	Strip cadmium plate previously covered by maskant, either by immersion or local application.	As reqd	PS 590 or Inhibited hydrochloric acid	Room	Room
11	Clean cold water rinse.	0.5	Water	Room	Room
12	Clean hot water rinse.	0.5	Water	150 to 185	66 to 85
13	Air dry.	1.0	Shop air	-	-

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

METHOD B

CAUTION

Pratt & Whitney approved fixture design shall be used when specified by WP/SWP for particular part(s) for operations using electric current, to avoid possibility of damage to parts.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
1	Mask areas not to be stripped. Refer to T.O. 2J-F100-53-1, SWP 092 12, and attach required fixtures.	-	-	-	-

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

NOTE

- Refer to T.O. 2-1-111 for solution preparation and maintenance.
- Parts requiring P&W approved fixture design shall be recleaned after relocating fixture attachment.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
2	Alkali clean. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 amperes per square foot (ASF). Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
3	Cold water rinse.	0.5	Water	Room	Room

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
4	Examine for water breaks. If water breaks occur, scrub areas to be stripped using alkali solution and pumice; then rinse.	1 to 5	Pumice, Grade FFF; PS 211 or 223	Room	Room

WARNING

Ensure that no PS 590 solution (ammonium nitrate) drips onto and then dries on any combustible material such as wood, cloth, or paper. Flammability will increase to cause an extreme fire hazard.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
5	Immerse in strip solution until all cadmium plate is removed.	As reqd	PS 590	Room	Room
6	Cold water rinse.	0.5	Water	Room	Room
7	Mask nickel plate repaired areas, extending 0.030 inch minimum beyond entire repair boundaries. Apply maskant by brush in several coats to a thickness of 0.020 inch minimum, filling all voids and providing protection for sharp edges.	As reqd	Maskant	Room	Room

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C

CAUTION

Prevent contamination by cadmium of PS 325, or solution could become corrosive toward parts.

NOTE

Stripping time depends on thickness of plate and freshness of solution. Fresh solution will strip approximately 0.002 inch per hour at 175°F (79°C).

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
8	Immerse in mechanically agitated nickel strip solution.	As reqd	PS 325	125* to 175**	52* to 79**

*Reduce solution to room temperature when not in use, to prolong life.

**If parts are masked with wax, temperature shall not exceed 135°F (57°C).

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
9	Cold water rinse.	0.5	Water	Room	Room

WARNING

PS 302 contains cyanide which is extremely poisonous. Ensure no personal contact. Provide adequate ventilation and use appropriate protection.

Opera-tion No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10	a. Immerse in cyanide cleaning solution. No current.	1 to 2	PS 302	Room	Room

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
10 (cont)					

WARNING

PS 211 and 223 contain cyanide which is extremely poisonous. Use appropriate protection.

Operation No.	Description of Operation	Time Mins	Solutions, Materials, and Current	Temp °F	Temp °C
	b. (Alternate to Operation 10a.) Immerse in alkaline cyanide cleaner. Current to be OFF when immersing or withdrawing parts.	1 to 3	PS 211 or 223; 25 to 35 ASF. Periodic reverse cycle 10 seconds anodic, 10 seconds cathodic. End cycle on anodic.	110 to 130	43 to 54
11	Cold water rinse.	0.5	Water	Room	Room
12	Check for complete removal of nickel plate. If necessary, scrub with paste of pumice and water, then repeat Operations 7 through 12.	As reqd	Pumice, Grade FFF; Water	Room	Room
13	Rinse in clean hot water.	0.5	Water	150 to 185	66 to 85
14	Air dry.	1.0	Shop air	-	-
15	Remove maskant by peeling or immersing in heated degreasing solvent.	2 to 10	O-T-236 tetrachloroethylene (perchloroethylene)	248 to 256	120 to 124

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, SYMBOLS, PREPARATION, IDENTIFICATION, AND INSPECTION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 54

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 53	0				
54 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general depot maintenance welding information, including explanation of symbols, preparation for welds, marking identification, and typical inspection requirements.

2. GENERAL.

(See Table 1.)

a. Welding information is given in this work package to help understand repair instructions. This work package is not intended to provide basic welding procedures. Welders making weld repairs on flight engine parts, shall be fully qualified per MIL-STD-1595. Weld process codes are listed in table 1.

3. BASIC WELDING SYMBOL.

(See Figure 1 and table 1.)

a. The basic welding symbol is used on prints and illustrations as a direction to perform a weld operation. This symbol may have several parts, but not all parts are necessarily used. Each part is explained as follows:

(1) The REFERENCE LINE is a horizontal line.

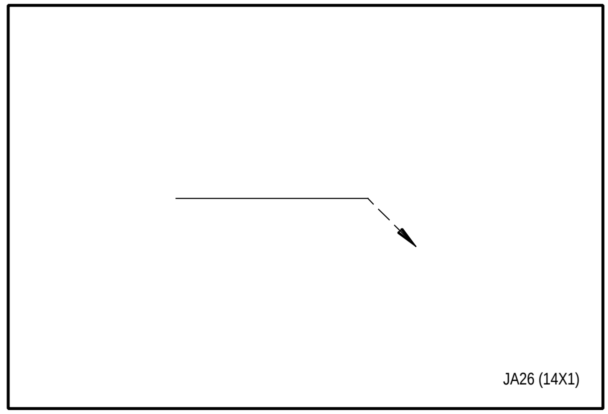


Figure 1. Basic Welding Symbol (Sheet 1 of 17)

Table 1. Weld Process Codes

Weld Process	AWS Letter Designation
Manual Gas Tungsten Arc (TIG)	GTAW-MA
Machine Gas Tungsten Arc (TIG)	GTAW-ME
Manual Gas Metal Arc (MIG)	GMAW-MA
Machine Gas Metal Arc (MIG)	GMAW-ME
Electron Beam	EBW
Manual Plasma Arc (Transferred Arc)	PAW-MA
Machine Plasma Arc (Transferred Arc)	PAW-ME
Resistance Weld	RW
Resistance Spot Weld	RSW
Resistance Seam Weld	RSEW

b. The ARROW may start from either end of reference line and points directly to weld joint.

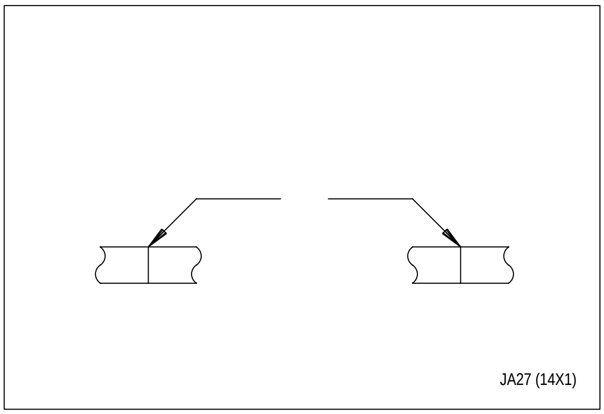


Figure 1. Basic Welding Symbol (Sheet 2 of 17)

Exception: For spot, stitch, or seam welds, arrow indicates weld centerline. This is illustrated in a later paragraph. A bent arrow has a special meaning, which will also be explained in a later paragraph.

c. The TAIL is a fork at the end of the reference line opposite arrow. In the tail is located the American Welding Society (AWS) process code for a type of welding, such as GTAW (gas tungsten arc or TIG), GMAW (gas metal arc or MIG), EBW (electron beam weld), or other reference denoting type of welding. (See table 1.) If no code is used, TAIL may be omitted.

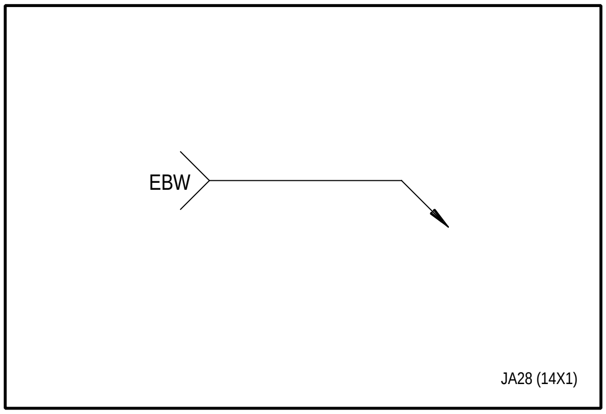


Figure 1. Basic Welding Symbol (Sheet 3 of 17)

d. The WELD SYMBOL is the central part of the basic welding symbol. There are many different weld symbols, which are generally those of AWS A3.0. Each one tells something about the configuration of the weld. It may mean that a fillet is required (a certain kind of groove machined by way of preparation for the weld), a certain flange is to be welded, or a spot weld is to be made.

(1) The most common weld symbols are illustrated and explained in later paragraphs. Some of these symbols have been discontinued (replaced by revised symbols). They are still included since the symbols may appear on older prints. When shown, they will be identified as DISCONTINUED.

(2) The following example indicates that a fillet weld is to be made:

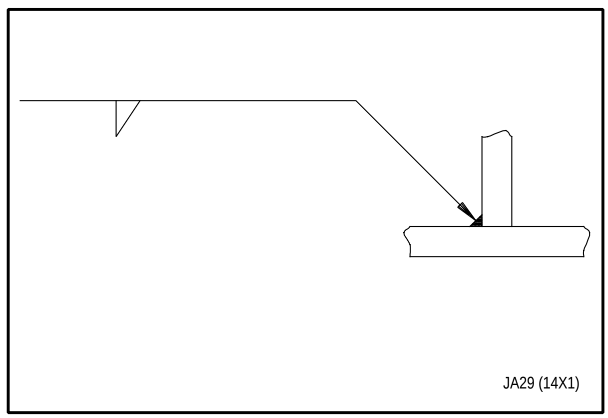


Figure 1. Basic Welding Symbol (Sheet 4 of 17)

(3) If WELD SYMBOL appears below the reference line, as in the preceding example (called ARROW SIDE), it means that weld is to be made at side of joint to which arrow points.

(4) If WELD SYMBOL appears above the reference line, it means that weld is to be made at side opposite joint to which arrow points (called OTHER SIDE). The following example illustrates this condition:

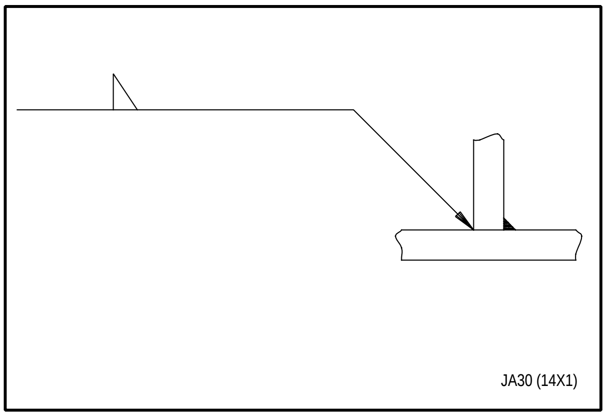


Figure 1. Basic Welding Symbol (Sheet 5 of 17)

(5) The WELD SYMBOL may appear above and below the reference line. In this case, welding is to be done on both sides of joint. The following example illustrates this condition:

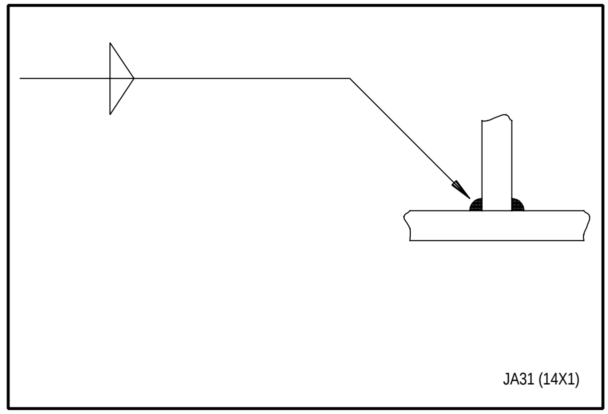


Figure 1. Basic Welding Symbol (Sheet 6 of 17)

(6) The only WELD SYMBOL which has no SIDE significance is the SURFACING symbol. This is illustrated in a later paragraph.

(7) Whenever possible, illustration is shown so that ARROW SIDE is used for simple welds made at only one side of joint.

e. The WELD ALL-AROUND symbol is a circle placed at point where arrow joins reference line. It means that weld extends completely around joint. This symbol is classified as a SUPPLEMENTARY weld symbol.

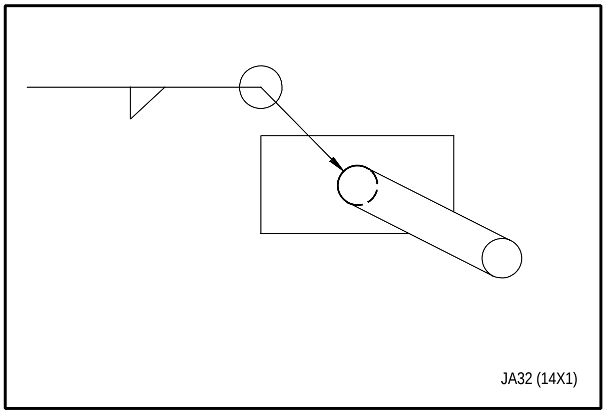


Figure 1. Basic Welding Symbol (Sheet 7 of 17)

f. The NUMBER of spot or projection welds appears beneath weld symbol, if below reference line or over weld symbol, if above reference line.

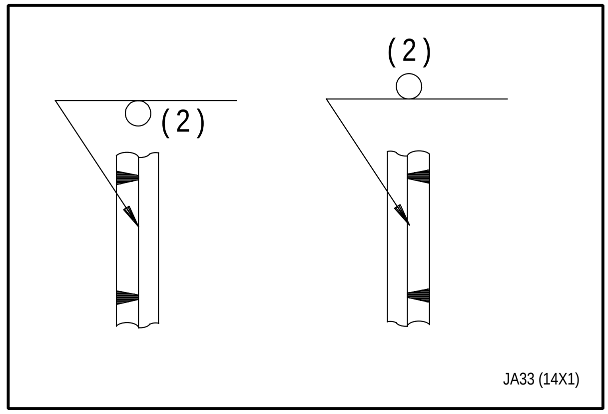


Figure 1. Basic Welding Symbol (Sheet 8 of 17)

g. DIMENSIONS may be shown in the following cases:

(1) DIMENSIONS less than 1 inch show three digits to the right but does not have a zero to left of decimal point. DIMENSIONS in even inches are shown only in whole numbers, without a decimal point. DIMENSIONS appear on same SIDE as WELD SYMBOL.

(2) For a plug weld, a DIMENSION for depth to which hole is to be filled, is placed in the weld symbol. The weld symbol for PLUG WELD will be explained in a later paragraph.

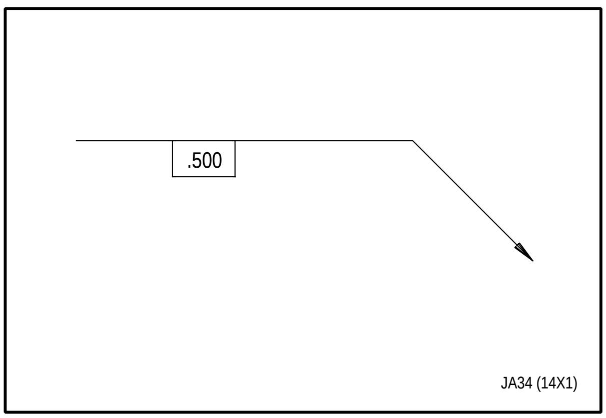


Figure 1. Basic Welding Symbol (Sheet 9 of 17)

(3) For a fillet weld, a DIMENSION for size of fillet is placed to left of weld symbol.

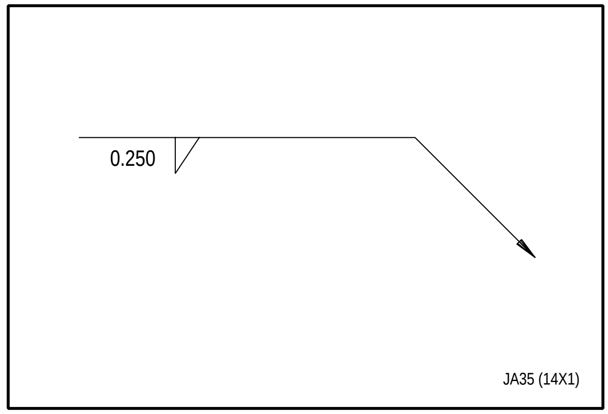


Figure 1. Basic Welding Symbol (Sheet 10 of 17)

(4) For a spot resistance weld, DIMENSIONS for minimum shear strength (pounds force per spot) and spot diameter (inches) may be placed to left of weld symbol, with spot diameter in parentheses.

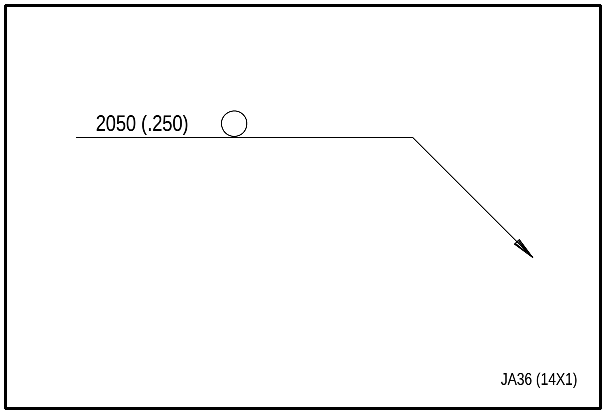


Figure 1. Basic Welding Symbol (Sheet 11 of 17)

(5) Other DIMENSIONS for thickness of backing welds, penetration, etc are explained in later paragraphs.

h. The CONTOUR symbol indicates either CONVEX or FLUSH weld surface.

(1) The CONTOUR symbol is classified as a SUPPLEMENTARY weld symbol.

(2) The CONTOUR symbol is placed beneath weld symbol, if below reference line and over weld symbol, if above reference line.

(3) The weld symbol for SQUARE GROOVE is used in the following illustration in order to show position of CONTOUR symbols. The SQUARE GROOVE symbol will be explained in a later paragraph.

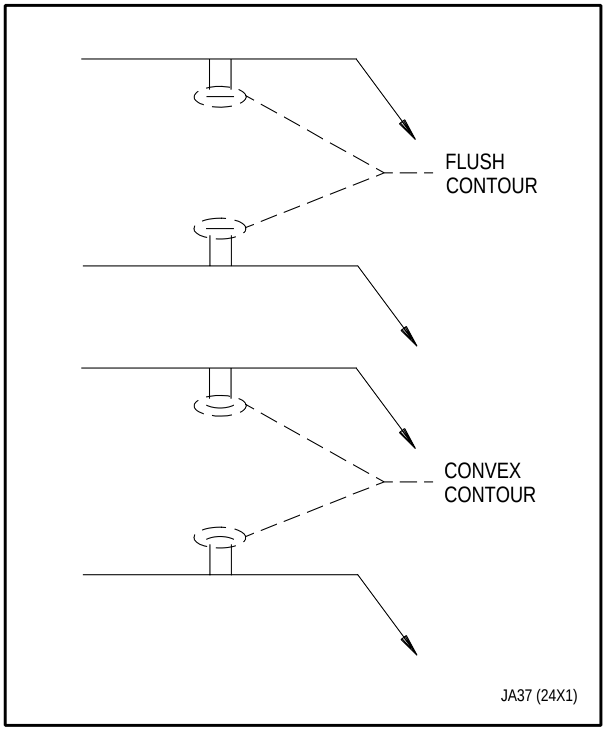


Figure 1. Basic Welding Symbol (Sheet 12 of 17)

i. When FINISHING is required after welding to specified contour, the Letter F is placed above or below contour symbol, as appropriate.

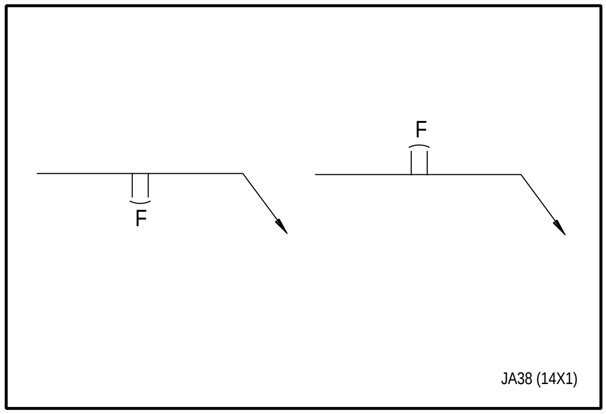


Figure 1. Basic Welding Symbol (Sheet 13 of 17)

j. When a toleranced DIMENSION is provided for FINISHING (weld height), it appears in place of the Letter F. These and other finishing conditions are more completely explained in later paragraphs.

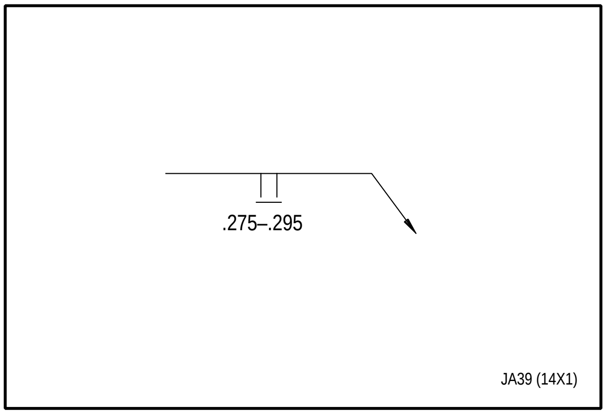


Figure 1. Basic Welding Symbol (Sheet 14 of 17)

k. GROOVE ANGLE, as the included angle of countersink in preparation for a plug weld, is shown above or below weld symbol, as appropriate.

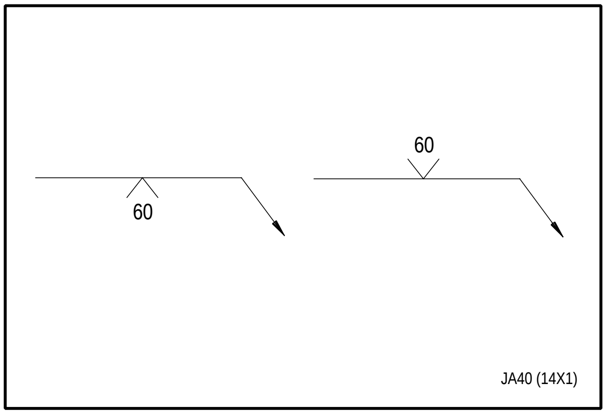


Figure 1. Basic Welding Symbol (Sheet 15 of 17)

l. LENGTH of interrupted welds, as in seam welding, is indicated to right of weld symbol, followed by a dash, then the PITCH or center distance when series of welds is used. This condition is explained more fully in later paragraphs.

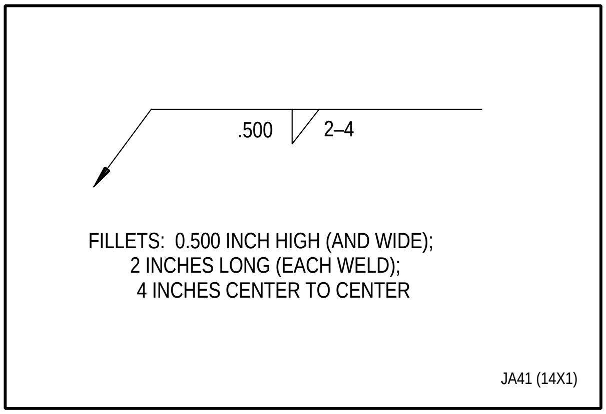


Figure 1. Basic Welding Symbol (Sheet 16 of 17)

m. An S in parentheses at right of weld symbol indicates STITCH welding. Usually the minimum spot diameter for the overlapping spots that comprise the STITCH will be shown in parentheses at left of weld symbol.

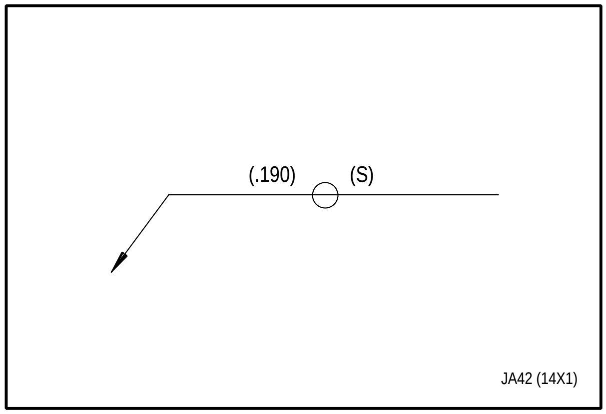


Figure 1. Basic Welding Symbol (Sheet 17 of 17)

4. WELD SYMBOLS.

(See Figure 2.)

a. Each of the weld symbols is shown in figure 2, together with a typical example of its significance. Additional information regarding application and variations of weld symbols follows these illustrations:

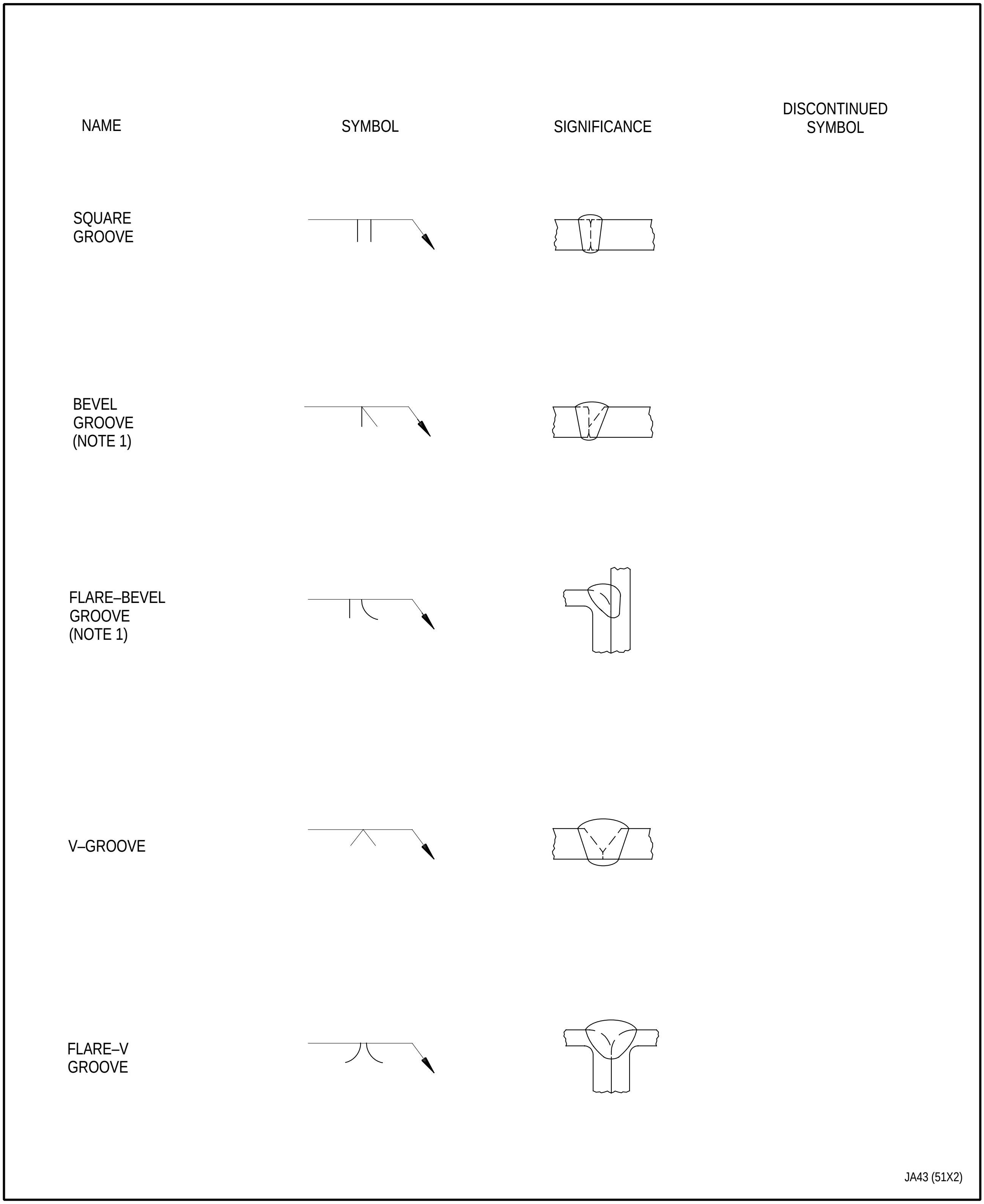


Figure 2. Weld Symbols (Sheet 1 of 4)

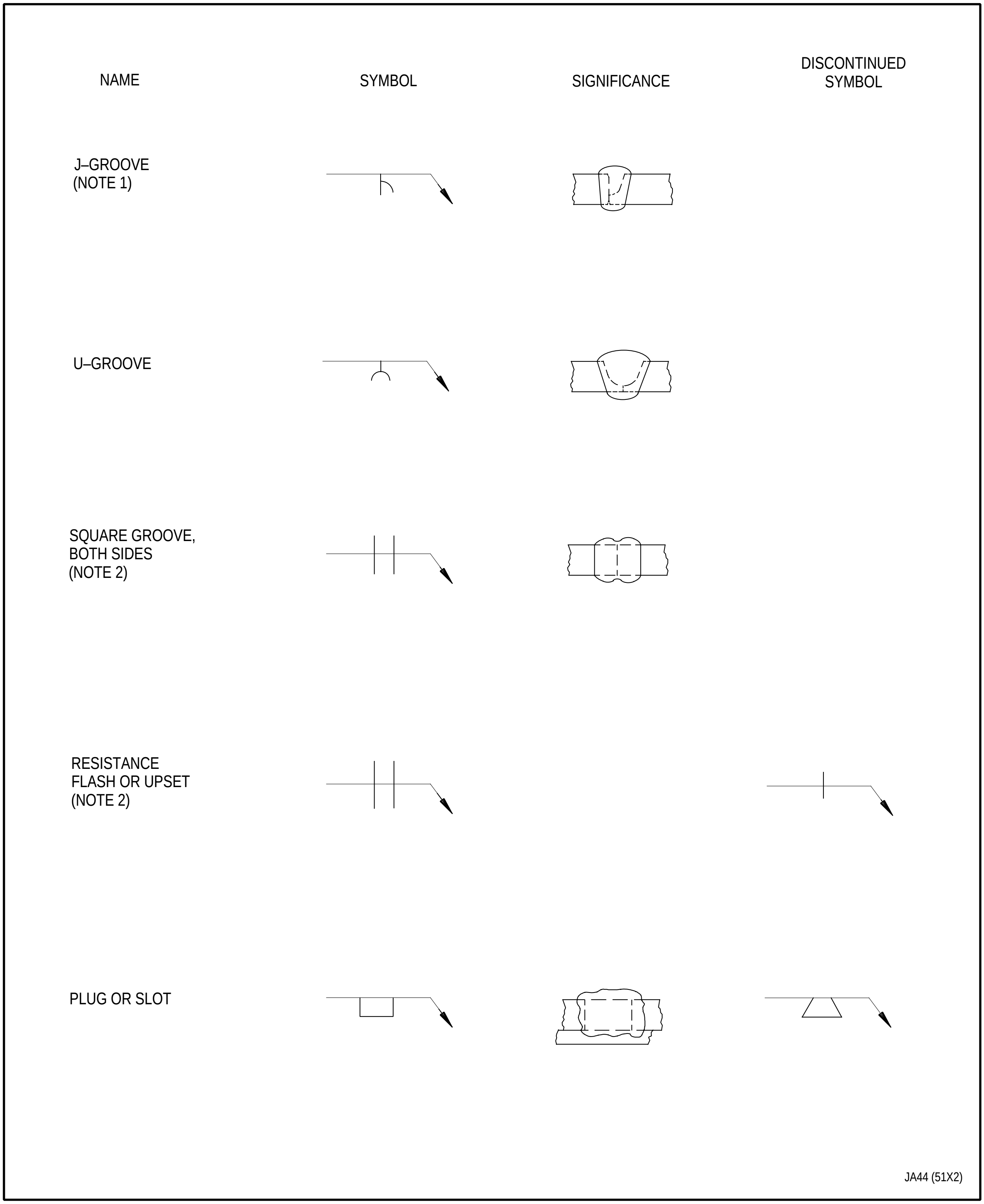


Figure 2. Weld Symbols (Sheet 2 of 4)

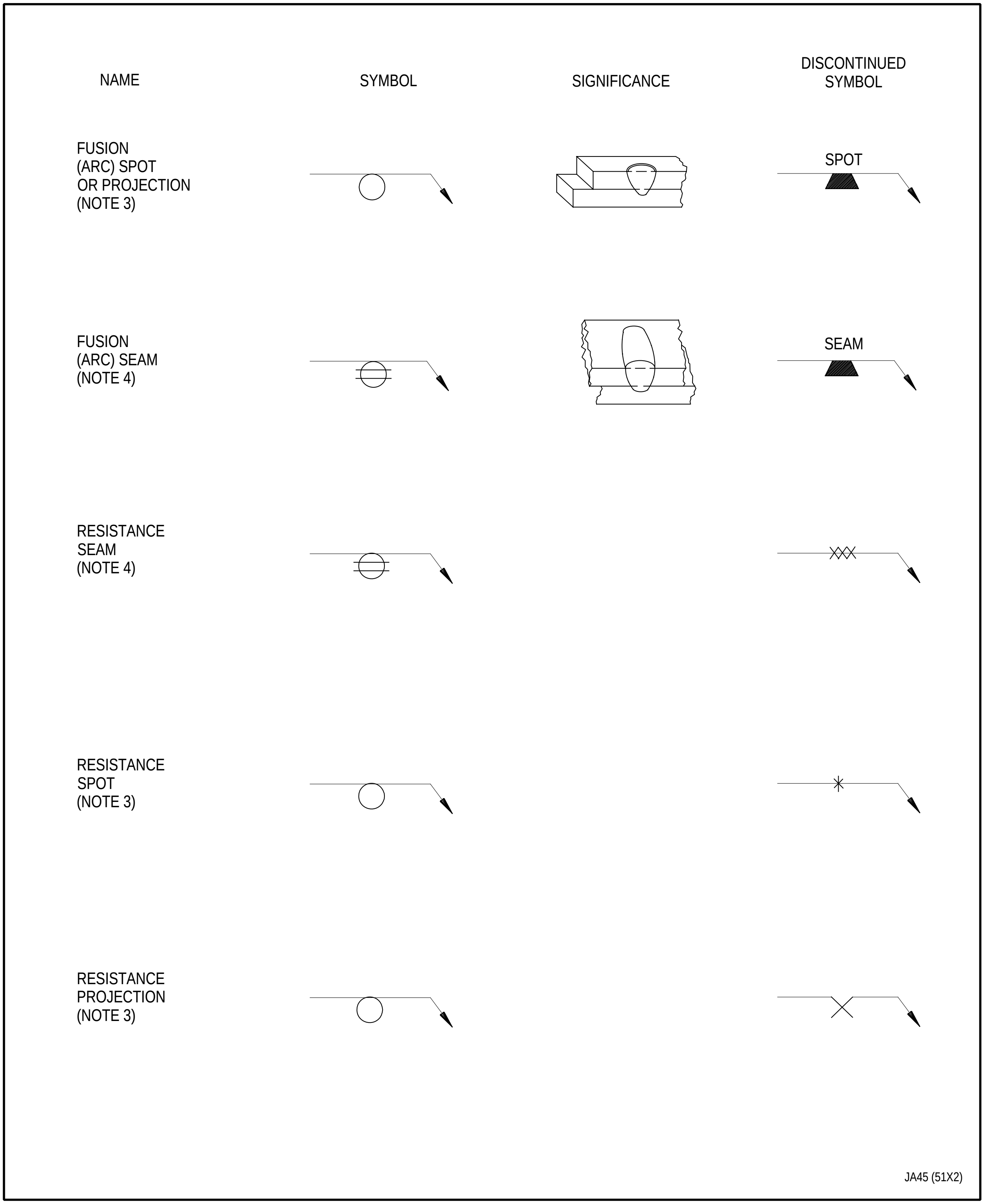


Figure 2. Weld Symbols (Sheet 3 of 4)

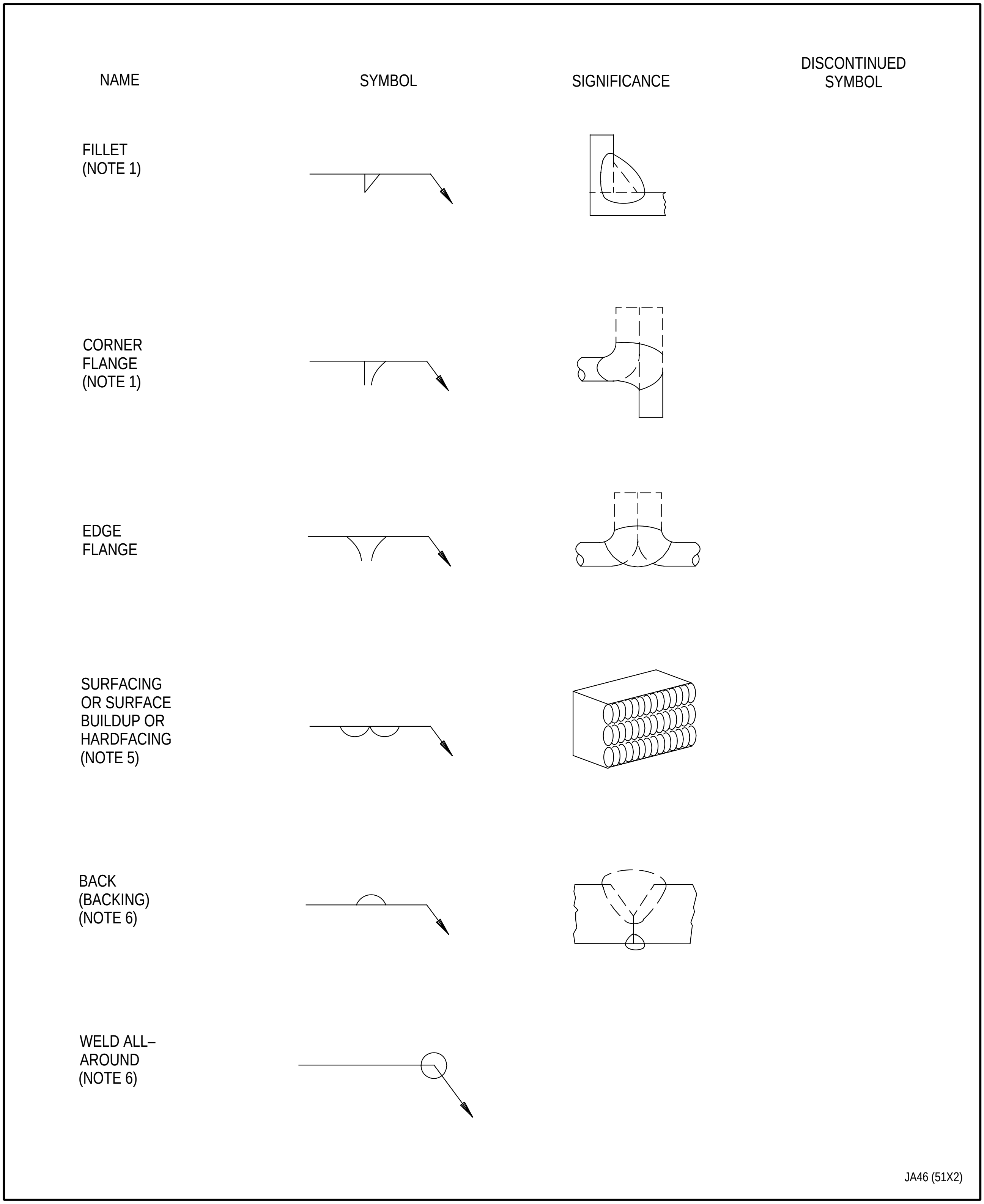


Figure 2. Weld Symbols (Sheet 4 of 4)

Legend for figure 2 (Sheets 1 through 4)

NOTES

1. Notice that left leg of symbol is always vertical.
2. Notice that current symbols are identical for square groove, both sides, and resistance flash or upset.
3. Notice that current symbols are identical for fusion (arc) spot or projection, resistance spot, and resistance projection.
4. Notice that current symbols are identical for fusion (arc) seam and resistance seam.
5. Does not indicate welding of a joint. No ARROW SIDE or OTHER SIDE significance.
6. Used only in combination with other weld symbols, and never alone as shown here.

5. BENT ARROW.

(See Figure 3.)

a. When one joined member is to be prepared (ground or machined), bent arrow points toward that member. If preparation is illustrated and dimensioned in WP/SWP, bent arrow is not used.

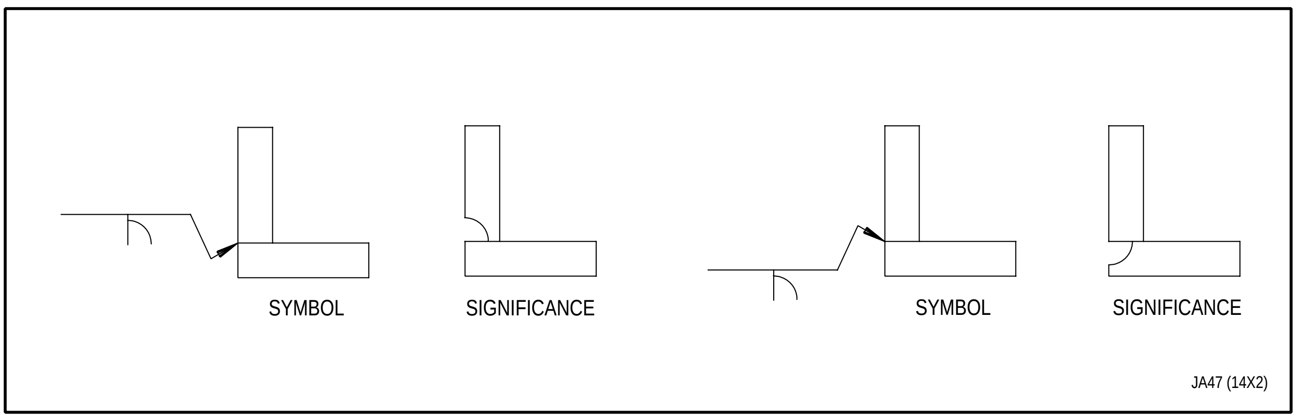


Figure 3. Bent Arrow Indicating Prepared Joint

6. SIDE SIGNIFICANCE.
(See Figure 4.)

a. If WELD SYMBOL appears below reference line, weld is to be made at side of joint to which arrow points. If WELD SYMBOL appears above reference line, weld is to be made at side opposite joint to which arrow points. If WELD SYMBOL is both above and below reference line, weld is to be made at both sides.

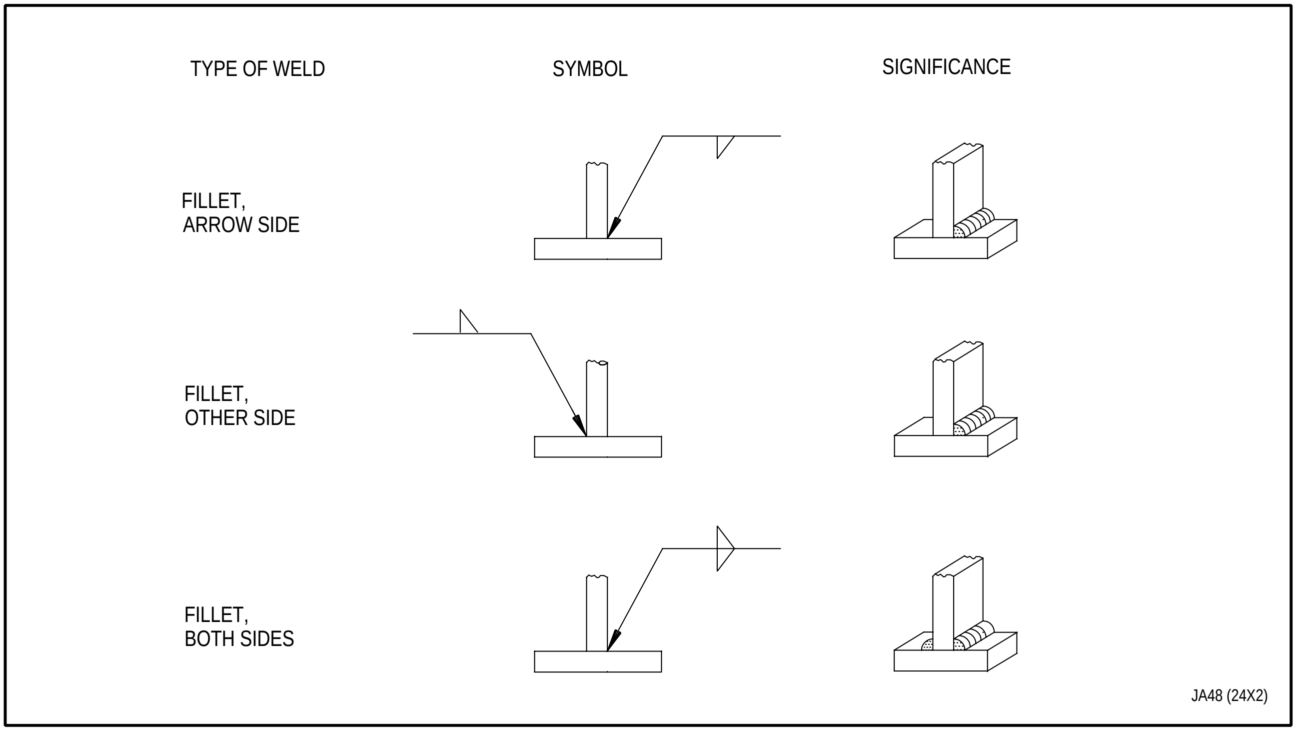


Figure 4. Side Significance

7. WELD JOINT FACING OBSERVER.
(See Figure 5.)

a. When the length of a weld joint faces the observer, ARROW SIDE is side toward observer, and OTHER SIDE is side opposite observer.

8. WELD-ALL-AROUND.
(See Figure 6.)

a. This symbol indicates that weld extends completely around joint indicated.

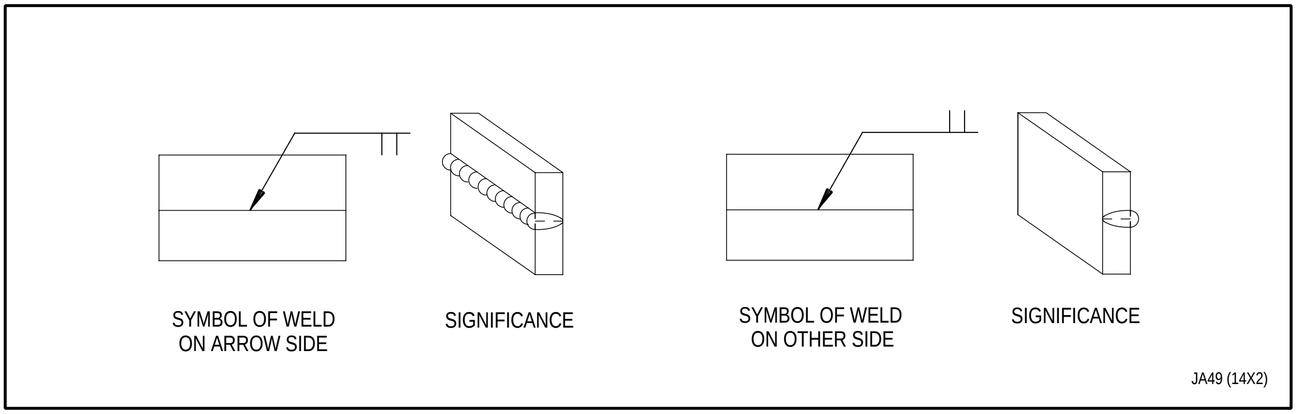


Figure 5. Weld Joint Facing Observer

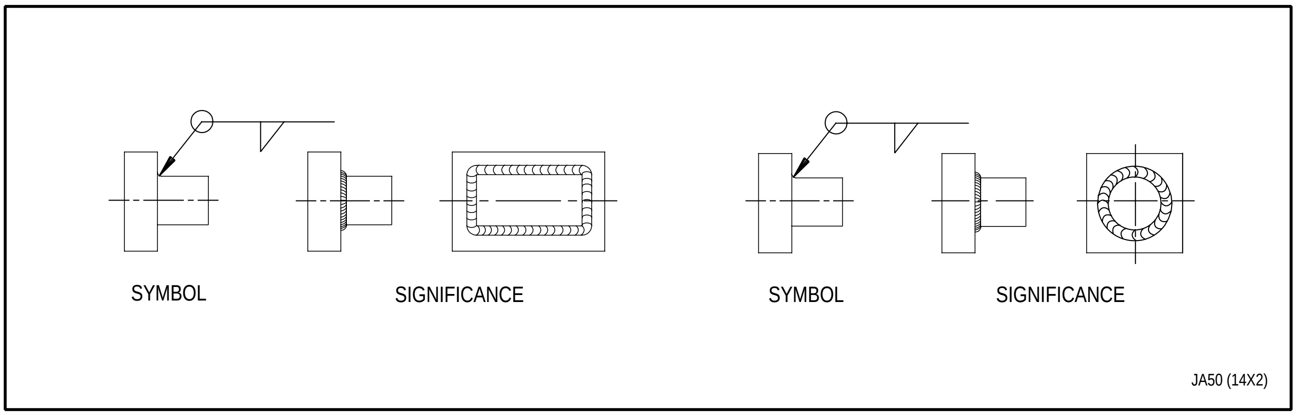


Figure 6. Weld-All-Around Symbol

9. FILLET WELDS.
(See Figures 7 through 10.)

a. The welding symbol shown in figure 7 indicates a 0.250 inch fillet weld extending the length of the joint (corner to corner). Other types of fillets are illustrated in figures 8 and 9. Where impractical to give extent and spacing of fillets in the symbol, data is shown with dimensional lines as in figure 10.

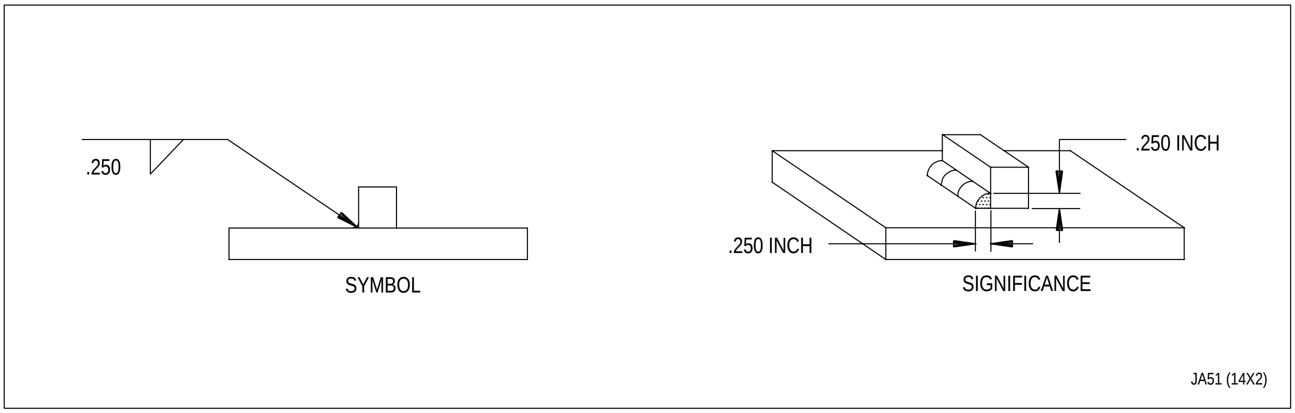


Figure 7. Fillet Weld for Length of Joint

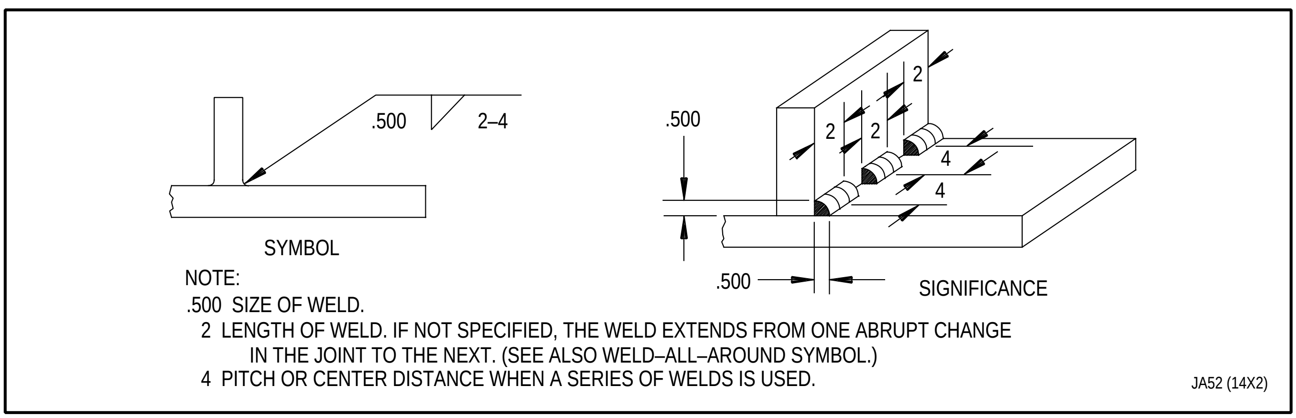


Figure 8. Intermittent Fillet Weld

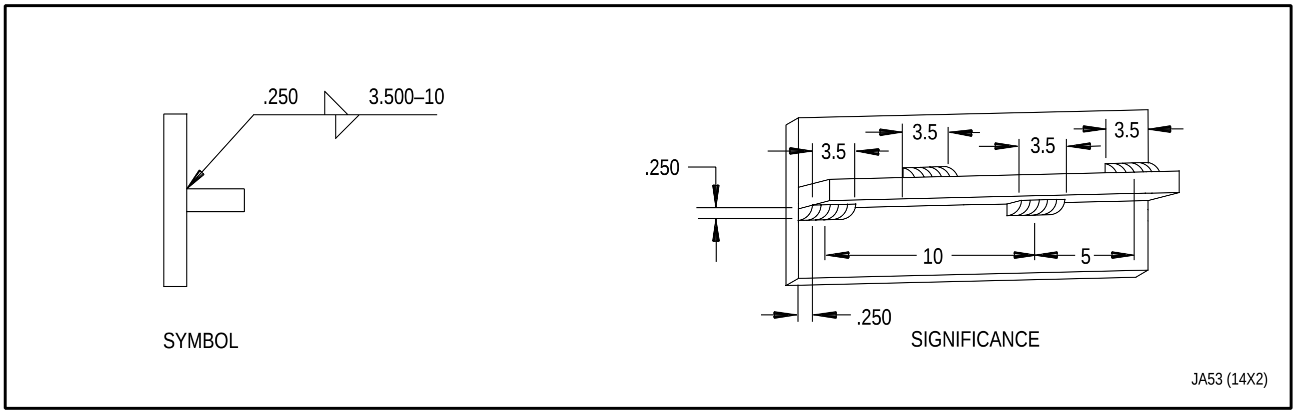


Figure 9. Staggered Intermittent Fillet Weld

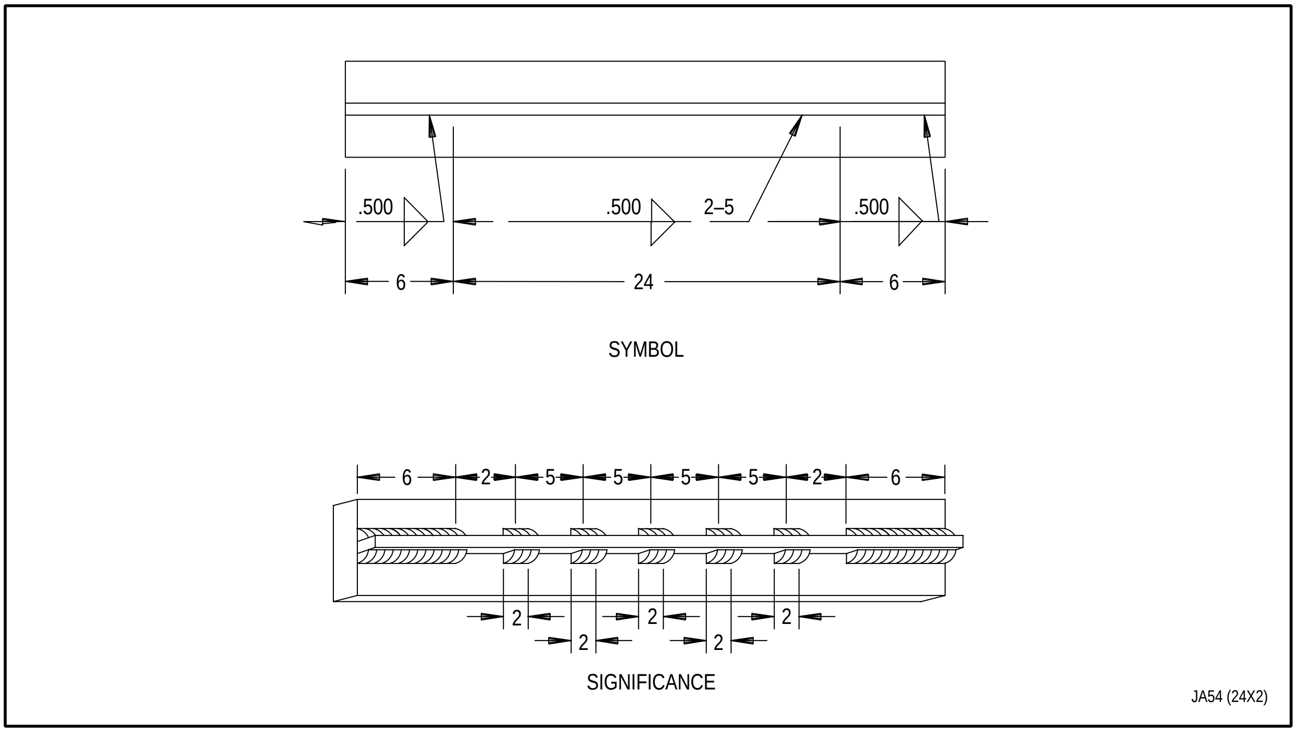


Figure 10. Extent of Fillet Welds for Special Cases

10. BACK (BACKING) WELDS.
(See Figure 11.)

a. The back (backing) weld symbol indicates that a small bead of metal is to be placed at other side of joint (opposite weld).

b. This symbol is only used together with a fusion weld symbol, never alone.

c. Minimum bead size is shown at left of backing symbol.

d. If minimum is less than 0.188 inch, then maximum is 2.0 times the minimum, as illustrated in figure 11. Since the minimum is 0.050 inch, maximum is 0.100 inch.

e. If minimum is 0.188 inch or greater, then maximum is 1.5 times the minimum.

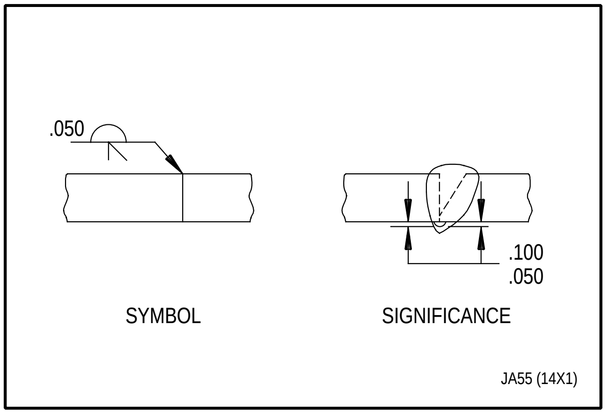


Figure 11. Backing Weld Symbol

11. SURFACE BUILDUP (SURFACING) OR HARDFACING.
(See Figure 12.)

a. Surface buildup or hardfacing is shown by a modified weld symbol, which does not indicate welding of a joint. There is no SIDE significance for this application.

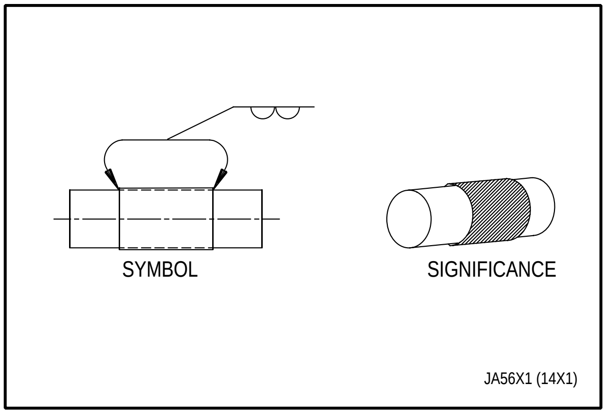


Figure 12. Surface Buildup or Hardfacing

12. GROOVE WELDS.
(See Figures 13 through 15 and Table 2.)

a. Groove welds include SQUARE GROOVE, BEVEL GROOVE, BEVEL GROOVE, FLARE-BEVEL GROOVE, V-GROOVE, FLARE-V GROOVE, J-GROOVE, and U-GROOVE. Data usually required in connection with groove welds are PREPARATION, WELD HEIGHT, and MISMATCH.

b. PREPARATION depends upon type of groove weld. Dimensions appear in WP/SWP as required.

c. WELD HEIGHT.

(1) Table 2 illustrates tolerances for groove weld height, showing frequent combinations for maximum and minimum conditions at ARROW SIDE and OTHER SIDE for square groove welds.

(2) Interpretation depends upon weld symbol, contour symbol (convex or flush), finishing (Letter F), and numerical dimensions in several combinations.

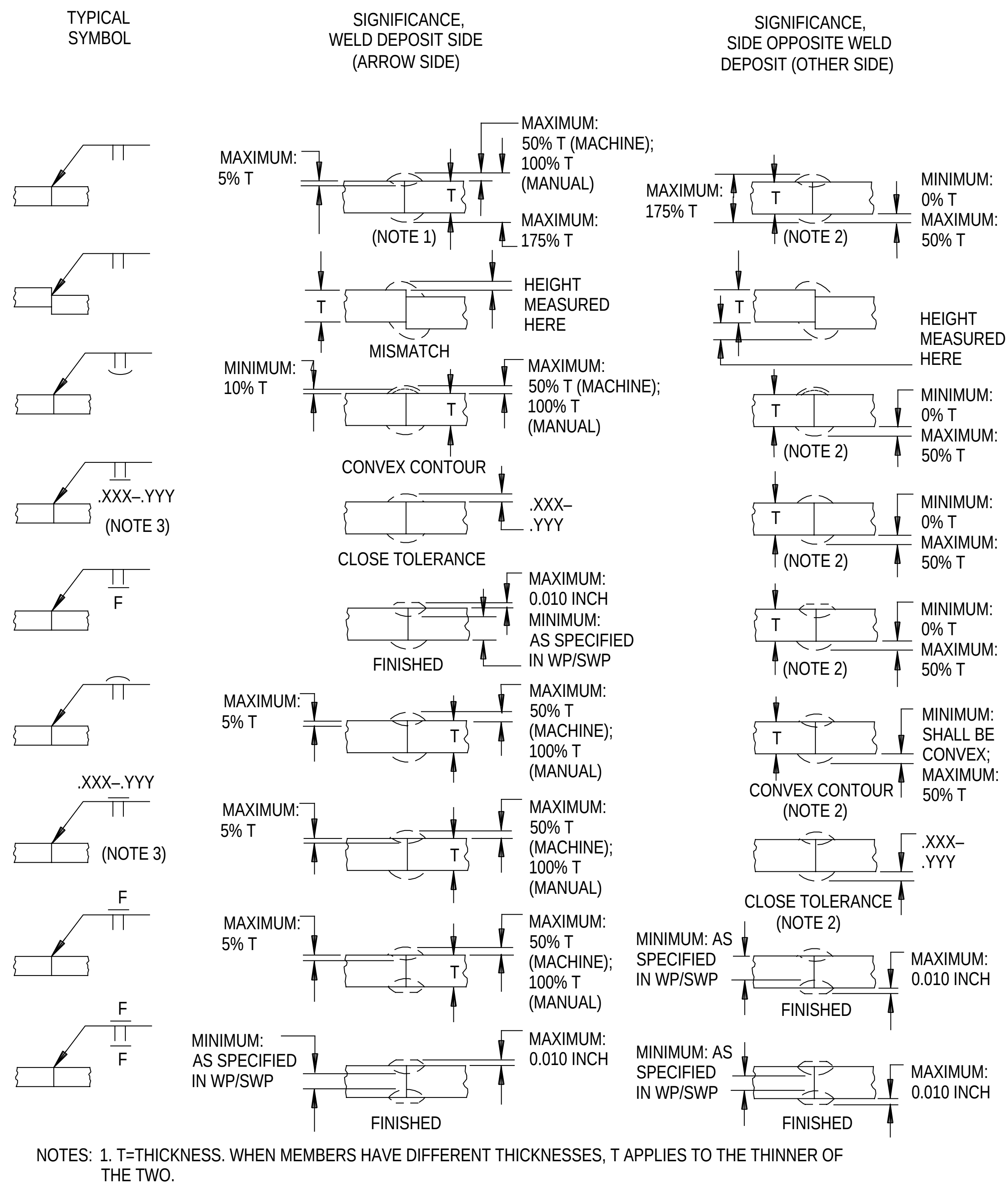
(3) Similar tolerances shall apply for other types of groove welds, as well as to plug, slot, spot, and seam welds.

d. FINISHING.

(1) Finishing of weld faces is optional unless specified in repair instructions in WP/SWP.

(2) Where finishing is required, the Letter F appears in the welding symbol, as shown in figure 2 and table 2, or a statement may be provided in WP/SWP.

Table 2. Groove Weld Height



NOTES: 1. T=THICKNESS. WHEN MEMBERS HAVE DIFFERENT THICKNESSES, T APPLIES TO THE THINNER OF THE TWO.
2. DOES NOT APPLY TO FLARE–GROOVE WELDS.
3. .XXX–.YYY REPRESENTS ANY PARTICULAR NUMERICAL TOLERANCE SPECIFIED IN WP/SWP.

(3) In rare cases if a weld is not to be finished, the symbol illustrated as shown in figure 13:

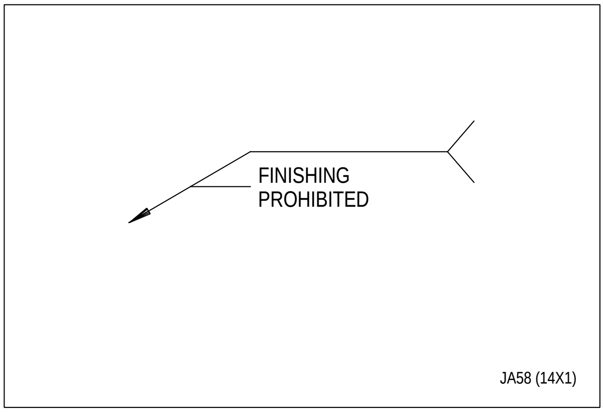


Figure 13. Symbol Prohibiting Finishing

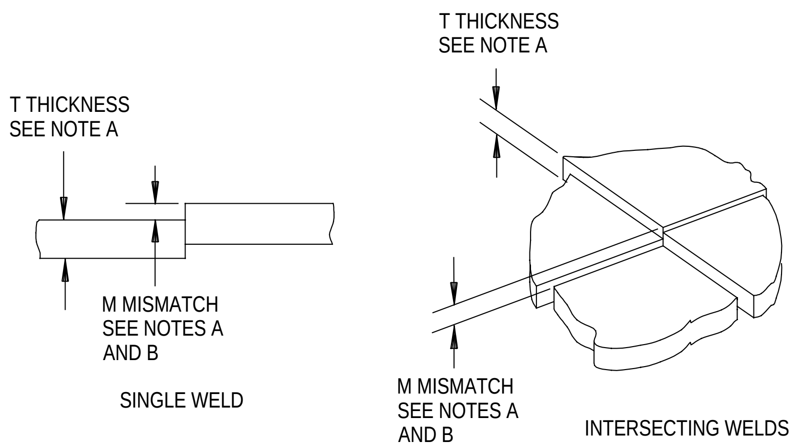
e. MISMATCH.

(1) Unless otherwise specified in WP/SWP, mismatch shall not exceed 25% of thickness of the thinner of pieces being joined, as illustrated in figure 14.

NOTE

Exception: If thinner piece is less than 0.050 inch thick, mismatch for up to 25% of length of weld may be up to 50% of thickness of the thinner piece.

(2) When different thicknesses are welded, measure mismatch from side which is flush; or, if neither side is flush, measure from centerlines of members being joined.



A. WHERE BUTTING THICKNESSES ARE UNEQUAL, T IS THICKNESS OF THINNER MEMBER, AND MISMATCH, M, IS MEASURED FROM SIDE SHOWN FLUSH ON THE ILLUSTRATION.

B. FOR SINGLE WELDS: M SHALL NOT EXCEED T/4.

EXCEPTION: FOR CIRCUMFERENTIAL WELDS, WHERE THICKNESSES ARE UNEQUAL AND T IS LESS THAN .050, M SHALL NOT EXCEED T/2 FOR 25 PERCENT OF WELD LENGTH AND SHALL NOT EXCEED T/4 FOR REMAINDER.

C. FOR INTERSECTING WELDS: M SHALL NOT EXCEED T/2.

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Figure 14. Mismatch Limits

(3) Mismatch at weld intersections shall not exceed 50% of thickness of thinner member.

(4) Total thickness of welded joint shall not be less than thickness of thinner member.

(5) Mismatch may be determined after fixturing or tack-welding and before final welding.

(6) When mismatch other than standard amount in figure 14 is required or permitted, limits shall be given as in figure 15, or specified in WP/SWP text.

(7) Equal mismatch in either direction is indicated by a symbol as in figure 15, View A.

(8) Unequal mismatch in either direction is indicated by a symbol as in figure 15, View B.

(9) Mismatch in one direction is indicated by a symbol as in figure 15, View C.

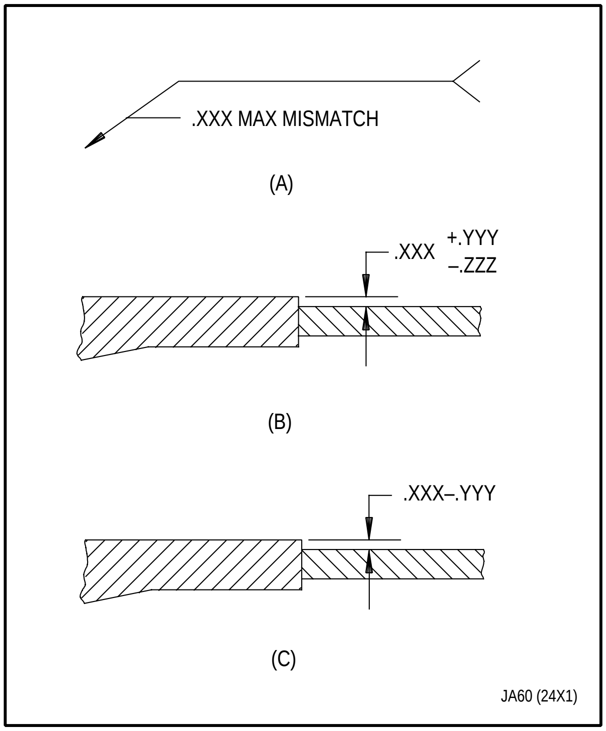


Figure 15. Special Mismatch Symbol

13. PENETRATION OF FUSION WELDS. (See figure 2 and Figures 16 through 21.)

a. Groove and flange welds shall have penetration complete throughout joint and to point of tangency in flare-groove welds. See figure 2.

b. Fillet welds shall have fusion at root (point of nearest approach of weld members) and along legs of weld. Fusion at root is not required, however, if members are joined at an angle less than 80 degrees. Depth of penetration is not limited, but weld metal buildup on side opposite weld deposit shall be kept to minimum.

c. Surfacing welds (hardfacing) shall show fusion at interface.

d. Back (backing) welds shall have fusion at root of joint.

e. Plug and slot welds shall have fusion at all interfaces. Depth of filling shall be complete.

f. Spot and seam welds shall have fusion at root of weld joint. When depth of penetration is specified by WP/SWP, measure from root of joint at last interface being welded.

g. Deviations from preceding penetration requirements are as follows:

(1) Square groove welds. Minimum acceptable penetration is indicated at left of weld symbol, as shown in figure 16.

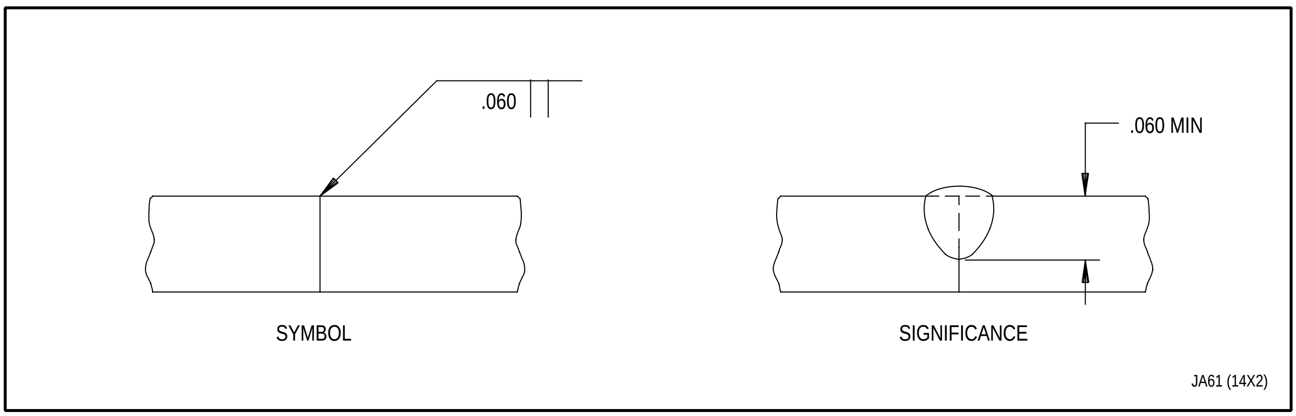


Figure 16. Incomplete Penetration for Square Groove Welds

(2) Bevel-groove, V-groove, J-groove, and U-groove welds. Minimum acceptable penetration is expressed as a sum of two dimensions at left of weld symbol. The first dimension represents minimum depth of preparation. The second dimension represents root penetration (penetration beyond prepared groove). A bevel groove is illustrated in figure 17 as a typical example, where penetration may be less than complete but is required for a depth of at least 0.130 inch. This includes minimum preparation depth of 0.070 inch, plus a root penetration of 0.060 inch.

(3) Flange welds. Minimum nugget size is indicated at left of weld symbol, as shown in figure 18.

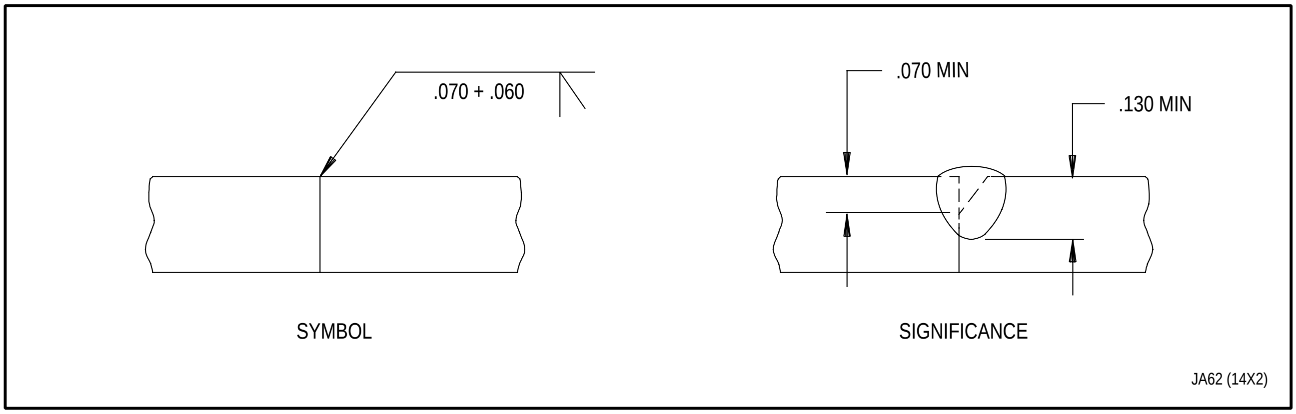


Figure 17. Incomplete Penetration for Bevel-, V-, J-, and U-Groove Welds

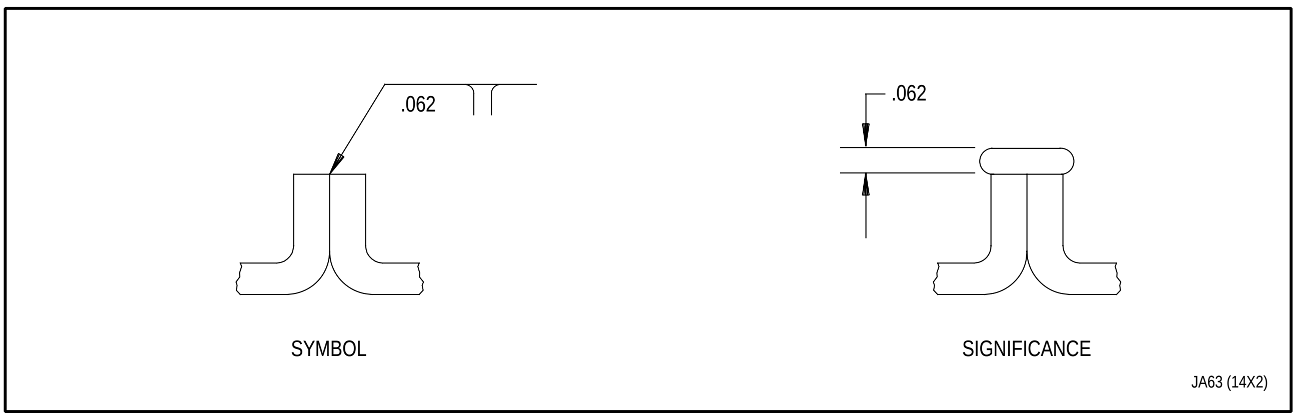


Figure 18. Incomplete Penetration for Flange Welds

(4) Fillet welds. Fillet welds normally have incomplete penetration. When there is a requirement for complete penetration, this is shown by combining fillet weld symbol with groove weld symbol as in figure 19.

(5) Arc spot and arc seam welds. Minimum depth of penetration is specified in welding symbol at a lead line to the arrow, as shown in figure 20. Figure 21 shows the same condition, using DISCONTINUED symbol. Depth of penetration is measured from root of joint at last interface in stack.

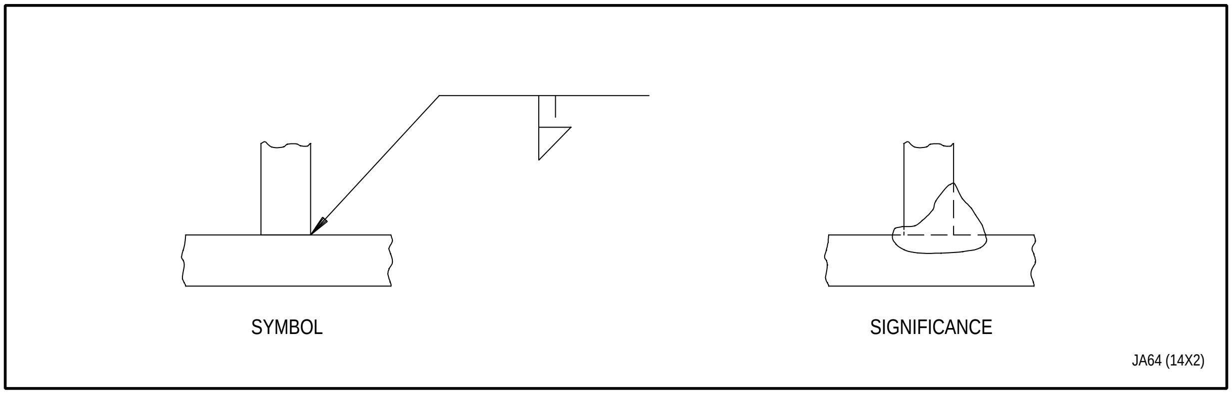


Figure 19. Complete Penetration for Fillet Welds

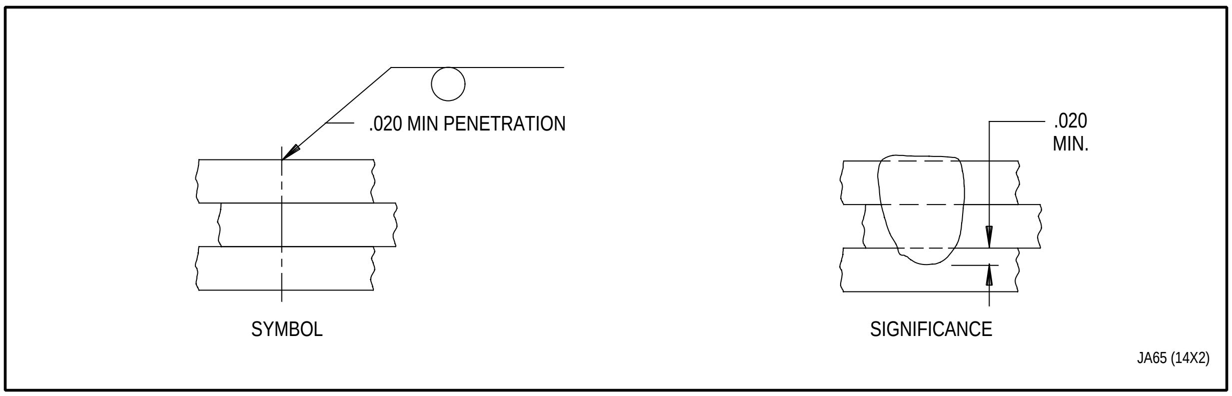


Figure 20. Depth of Penetration for Arc Spot or Arc Seam Welds

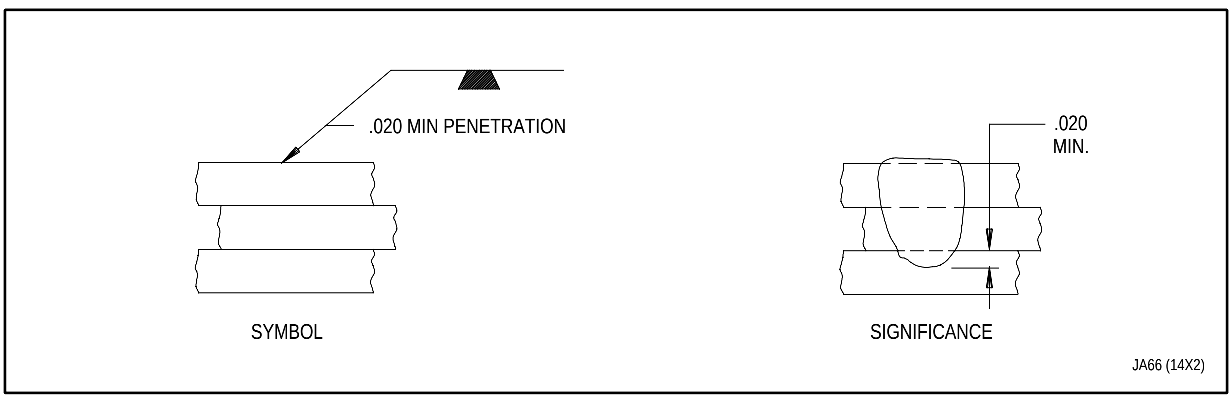


Figure 21. Discontinued Symbol for Depth of Penetration for Arc Spot or Arc Seam Welds

14. PLUG AND SLOT WELDS.
(See Figures 22 and 23.)

a. Dimensions are usually shown in illustration in WP/SWP rather than in welding symbol. Significance of symbols is shown in figure 22, showing current and discontinued symbols.

b. Dimensions for preparation are shown in WP/SWP. If average part thickness is more than 0.090 inch, edges shall be beveled to 60° ±10° including angle, as shown in figure 23. If part thickness is 0.090 inch or less, no bevel is required.

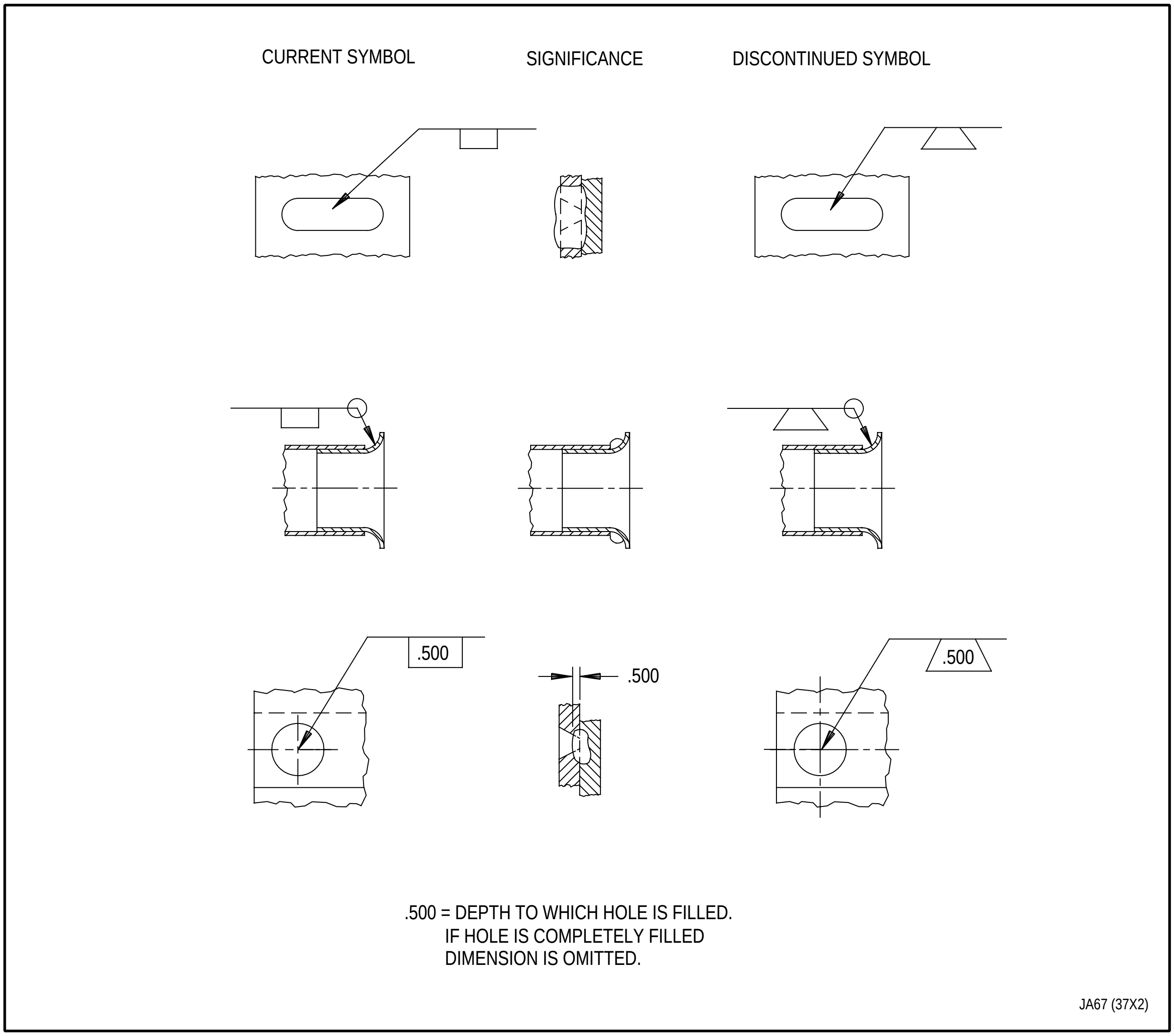


Figure 22. Plug and Slot Weld Symbols

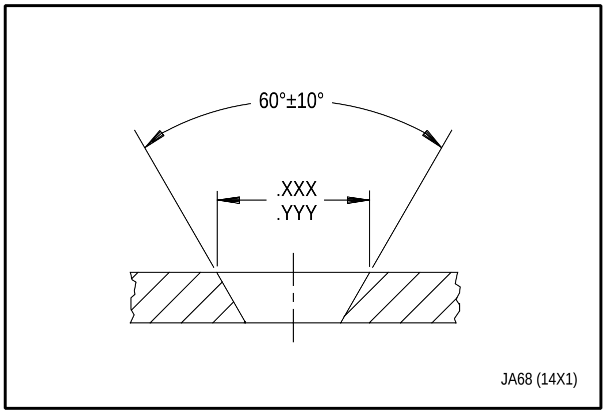


Figure 23. Preparation of Plug and Slot Welds

15. SPOT, STITCH, AND SEAM WELDS.
(See Figures 24 through 42.)

a. Where spot or seam welds have ARROW SIDE or OTHER SIDE significance, weld symbols appear either below or above reference line, as appropriate. Where there is no ARROW SIDE or OTHER SIDE significance, SPOT or SEAM symbol appears centered on reference line. Figures 24 and 25 illustrate typical conditions. Figures 26 through 29 show various conditions, using DISCONTINUED fusion weld symbols. Figures 30 through 32 show various conditions, using DISCONTINUED resistance weld symbols.

b. Minimum SPOT diameter is always indicated in the welding symbol. The minimum spot strength, pitch, and number of spots in a sequence may also be noted in welding symbol. Figure 24 shows how each of these requirements is noted.

c. Minimum SEAM width is always indicated in welding symbol. Minimum seam strength and seam length may also be indicated. Figure 25 shows how each of these requirements is noted.

d. Stitch welds are overlapping resistance spot welds. The Letter S in parentheses, used with the SPOT weld symbol, indicates STITCH welding. This is shown in figure 31. The corresponding DISCONTINUED symbol is shown in figure 32.

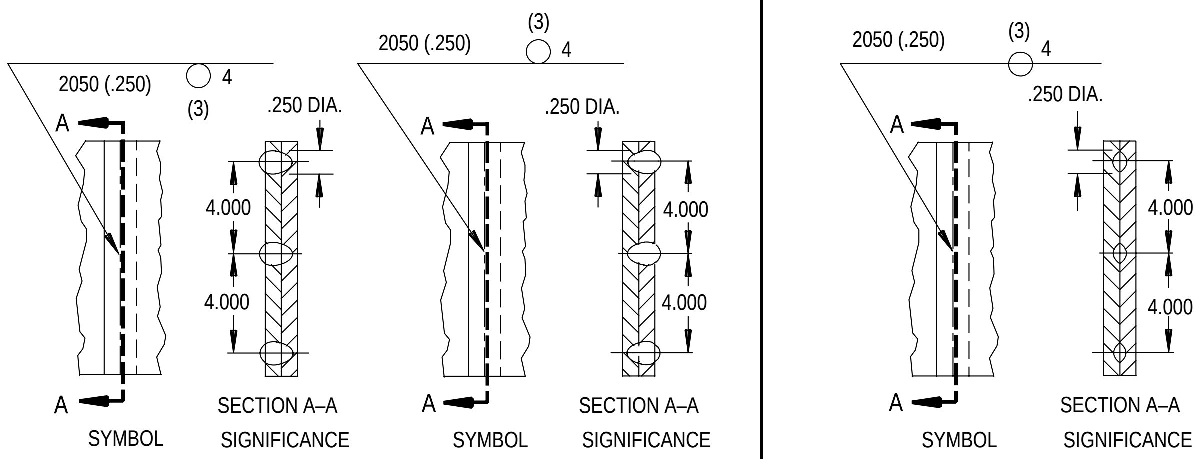
e. The LOCATION of stitch, seam, or a uniform run of spot welds is indicated in illustration by a centerline, as shown in figures 24 and 25. When it is necessary to show location of individual SPOT welds and use of a centerline would not be clear, the symbol <18-point>×</18-point> as shown in figure 35 is used. The corresponding arrangement using DISCONTINUED spot symbol is shown in figure 36.

f. MULTIPLE ARROWS.

(1) If a welding symbol has more than one arrow, it is just as if there were a separate symbol for each arrow. Where a number of SPOT welds is specified, as in figure 37, the number applies to each arrow. In this example, (2) SPOT welds are indicated; with three arrows, there will be two spots each, at the three locations, or a total of six. A similar arrangement is shown in figure 38, using DISCONTINUED spot symbol.

(2) An alternate use of multiple arrows may show number of PLACES in welding symbol instead of number of SPOTS, when this will simplify the illustration, In example given in figure 39, two (2) PLACES are shown, each with three SPOTS. Again, total number of welds will be three times two, or six. An example using the DISCONTINUED spot symbol, figure 40, shows four (4) PLACES, each with three SPOTS, or a total of 12 welds.

(3) When MULTIPLE arrows are applied to SEAM welding, each arrow indicates a weld at each interface in a stack. This condition is illustrated in figure 41. A similar arrangement is shown in figure 42, using DISCONTINUED seam welding symbol.



SPOT WELD SYMBOL WHERE WELD PROCESS HAS ARROW SIDE OR OTHER SIDE SIGNIFICANCE. (ARC SPOT WELD SHOWN.)

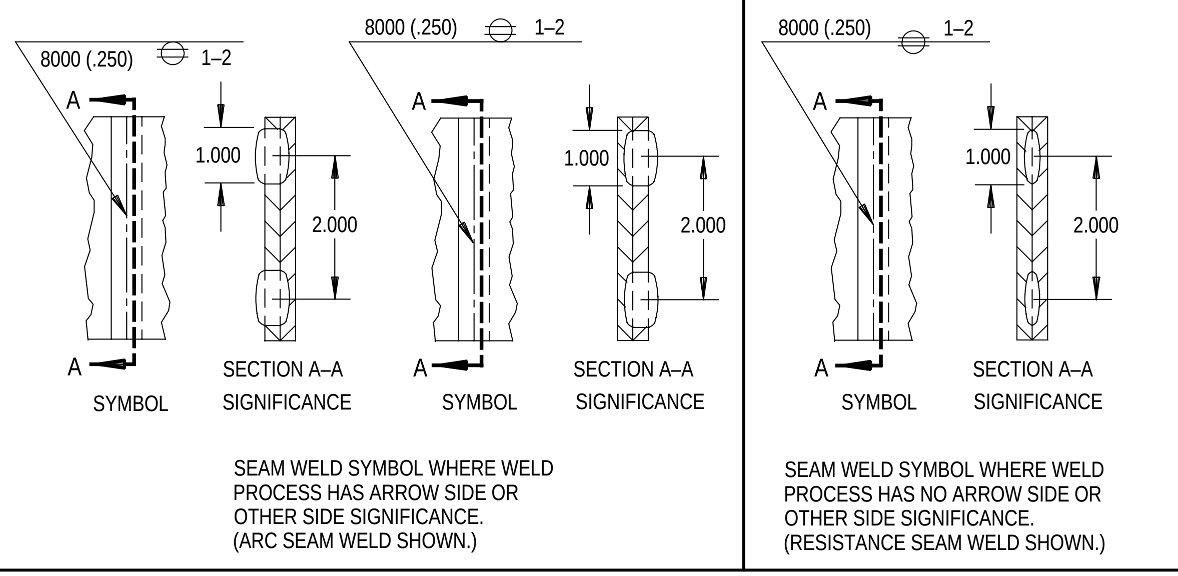
SPOT WELD SYMBOL WHERE WELD PROCESS HAS NO ARROW SIDE OR OTHER SIDE SIGNIFICANCE. (RESISTANCE SPOT WELD SHOWN.)

NOTATION:

2050 = MINIMUM SHEAR STRENGTH IN POUNDS PER SPOT. ALWAYS PLACED TO LEFT OF SPOT DIAMETER.
(.250) = MINIMUM SPOT DIAMETER IN INCHES MEASURED AT INTERFACE. ALWAYS PLACED TO THE LEFT OF THE SYMBOL. ALWAYS SHOWN IN PARENTHESIS.
(3) = NUMBER OF WELDS IN THE SEQUENCE. PLACED EITHER ABOVE OR BELOW SYMBOL. ALWAYS SHOWN IN PARENTHESIS.
4 = PITCH OR BASIC DISTANCE BETWEEN WELD CENTERS IN INCHES. ALWAYS PLACED TO RIGHT OF SYMBOL.

JA69 (36X2)

Figure 24. Spot Weld Symbol



NOTATION:

8000 = MINIMUM SHEAR STRENGTH IN POUNDS PER LINEAR INCH. ALWAYS PLACED TO LEFT OF SEAM WIDTH.

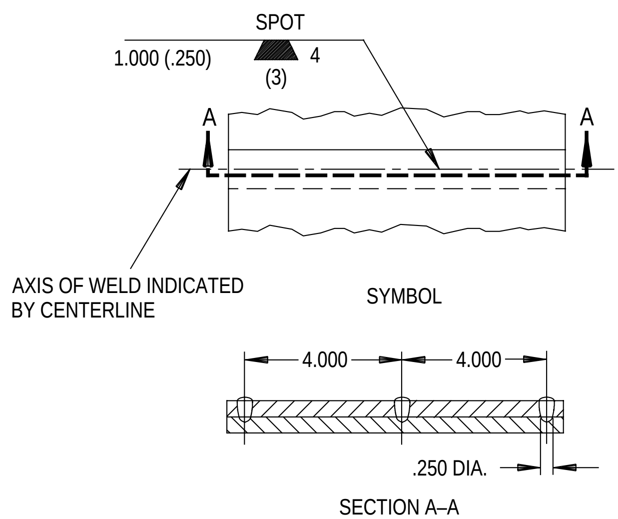
(.250) = MINIMUM SEAM WIDTH, IN INCHES (MEASURED AT INTERFACE). ALWAYS PLACED TO LEFT OF SYMBOL. ALWAYS SHOWN IN PARENTHESIS.

1 = MINIMUM SEAM LENGTH, IN INCHES. ALWAYS PLACED TO RIGHT OF WELD SYMBOL.

2 = PITCH, OR BASIC DISTANCE BETWEEN WELD CENTERS IN INCHES. ALWAYS PLACED TO RIGHT OF SEAM LENGTH AND SEPARATED FROM IT BY DASH.

JA70 (30X2)

Figure 25. Seam Weld Symbol



NOTATION: SIGNIFICANCE

1000= MINIMUM SHEAR STRENGTH IN POUNDS PER SPOT. ALWAYS PLACED TO LEFT OF SPOT DIAMETER.

(.250)= MINIMUM SPOT DIAMETER IN INCHES (MEASURED AT INTERFACE). ALWAYS PLACED TO LEFT OF SYMBOL ALWAYS SHOWN IN PARENTHESIS.

(3)= NUMBER OF WELDS IN THE SEQUENCE. ALWAYS PLACED OPPOSITE WIDEST SIDE OF SYMBOL ALWAYS SHOWN IN PARENTHESIS.

4= PITCH OR CENTER DISTANCE, IN INCHES, BETWEEN WELDS IN THE SEQUENCE. ALWAYS PLACED TO RIGHT OF SYMBOL

JA71 (37X2)

Figure 26. Discontinued Fusion Weld Arc Spot Symbol

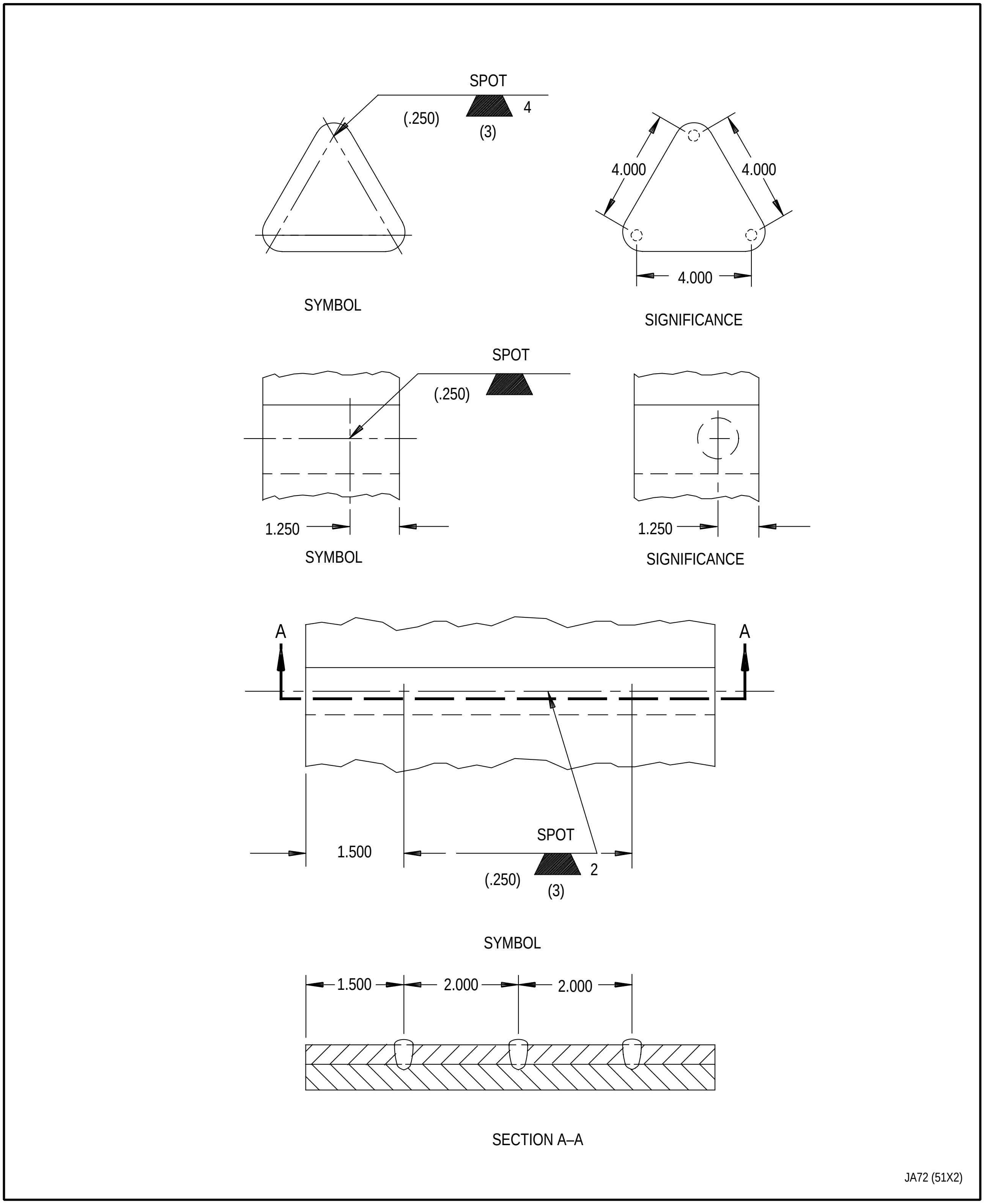


Figure 27. Discontinued Fusion Weld Arc Spot Symbol

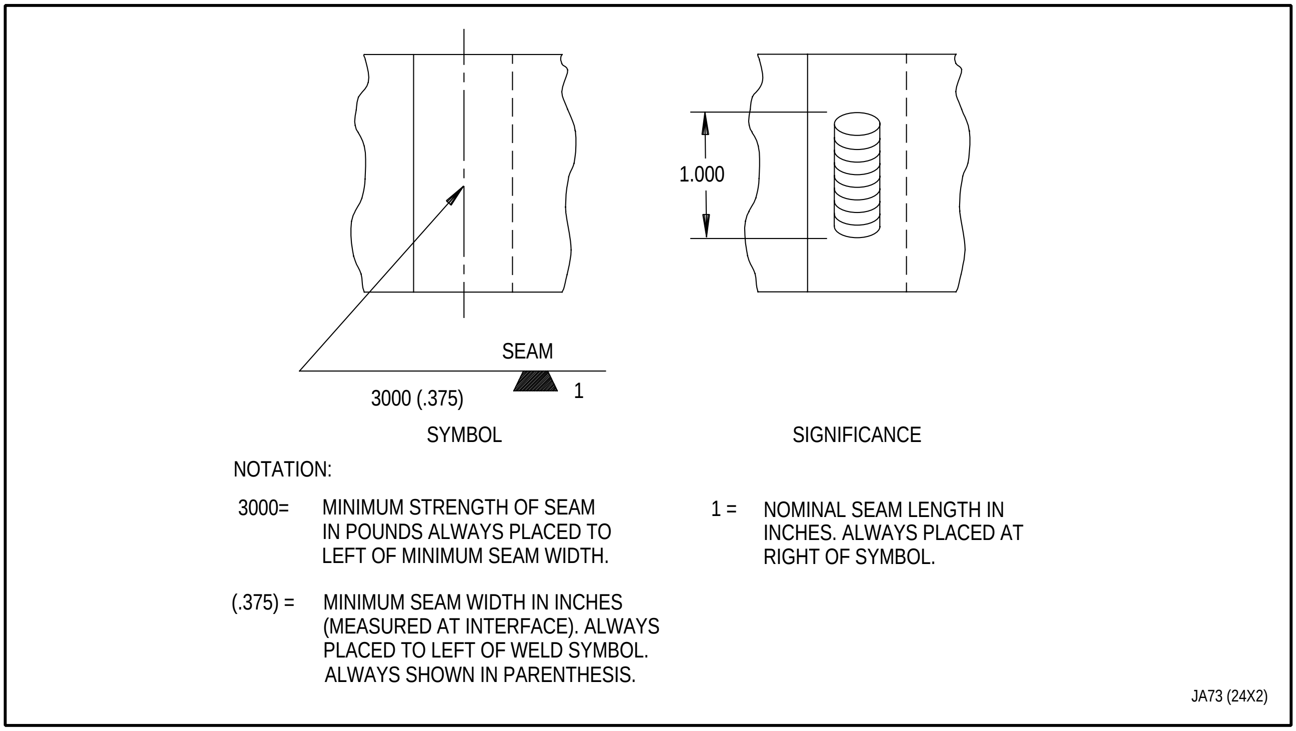


Figure 28. Discontinued Fusion Weld Arc Seam Symbol

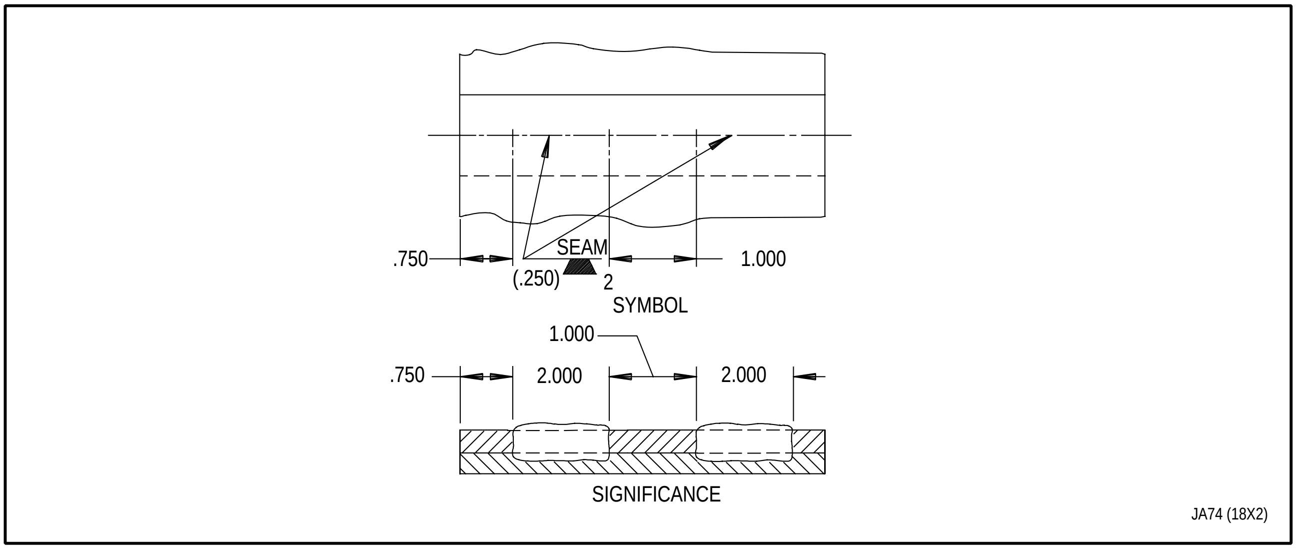


Figure 29. Discontinued Fusion Weld Arc Seam Symbol

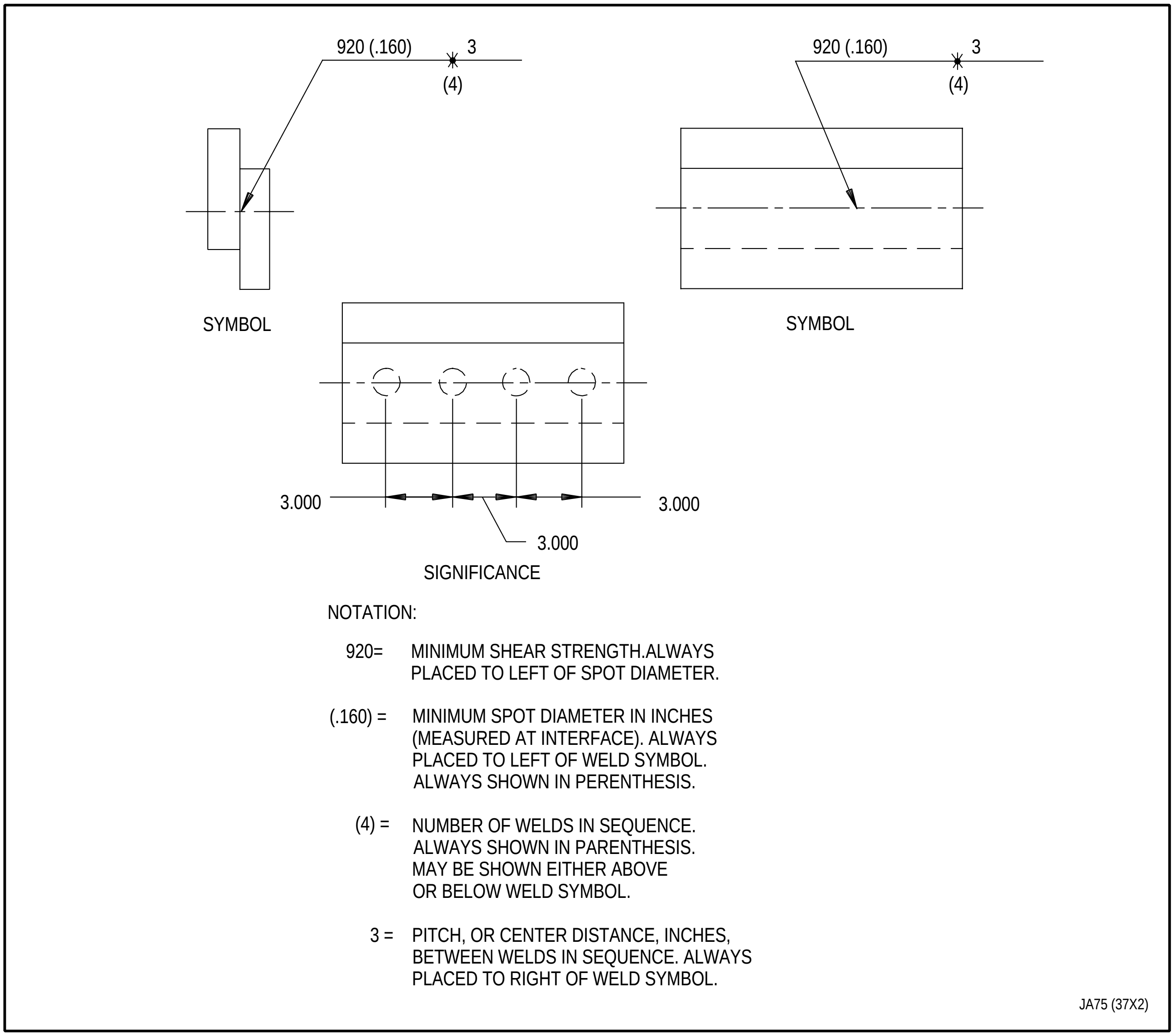
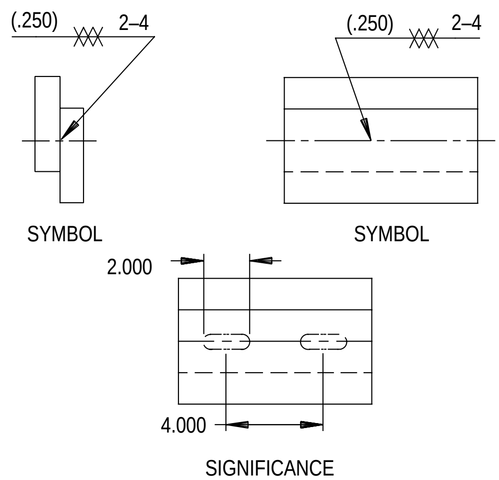


Figure 30. Discontinued Resistance Weld Spot Symbol



NOTATION:

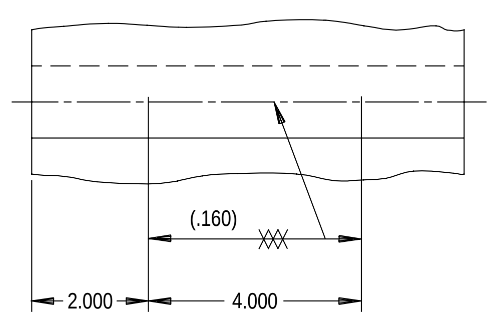
(.250)= MINIMUM SEAM WIDTH IN INCHES (MEASURED AT INTERFACE). ALWAYS PLACED TO LEFT OF WELD SYMBOL. ALWAYS SHOWN IN PARENTHESIS.

2 = MINIMUM SEAM LENGTH, IN INCHES , ALWAYS PLACED TO RIGHT OF WELD SYMBOL.

4 = PITCH OR CENTER DISTANCE BETWEEN WELDS, IN INCHES. ALWAYS PLACED TO RIGHT OF SEAM LENGTH.

JA76 (30X2)

Figure 31. Discontinued Resistance Weld Seam Symbol



JA77 (14X1)

Figure 32. Discontinued Resistance Weld Seam Symbol

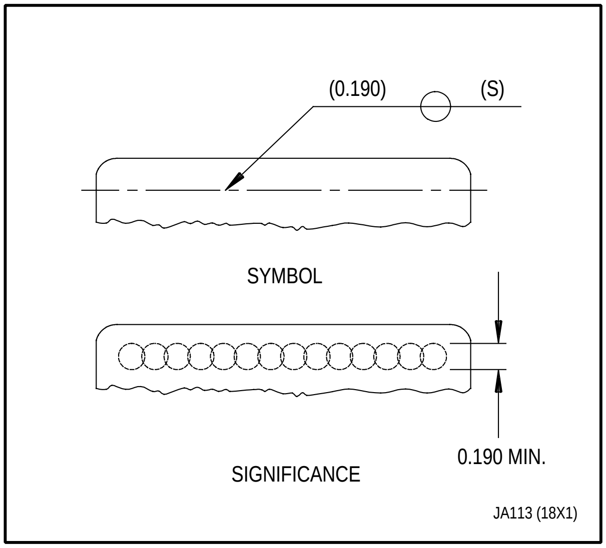


Figure 33. Stitch Weld Symbol

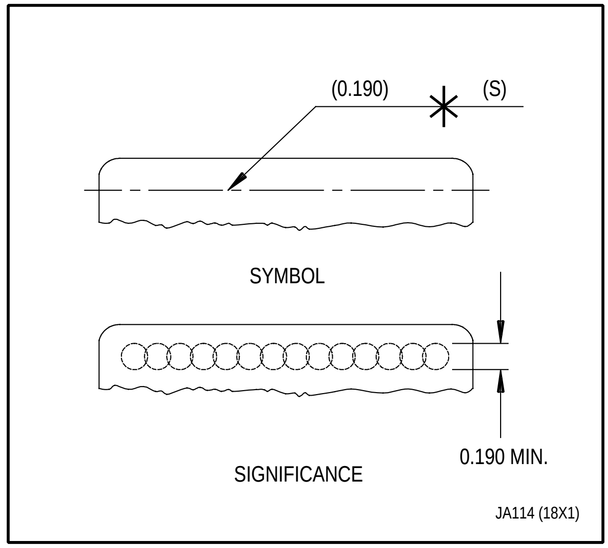


Figure 34. Discontinued Stitch Weld Symbol

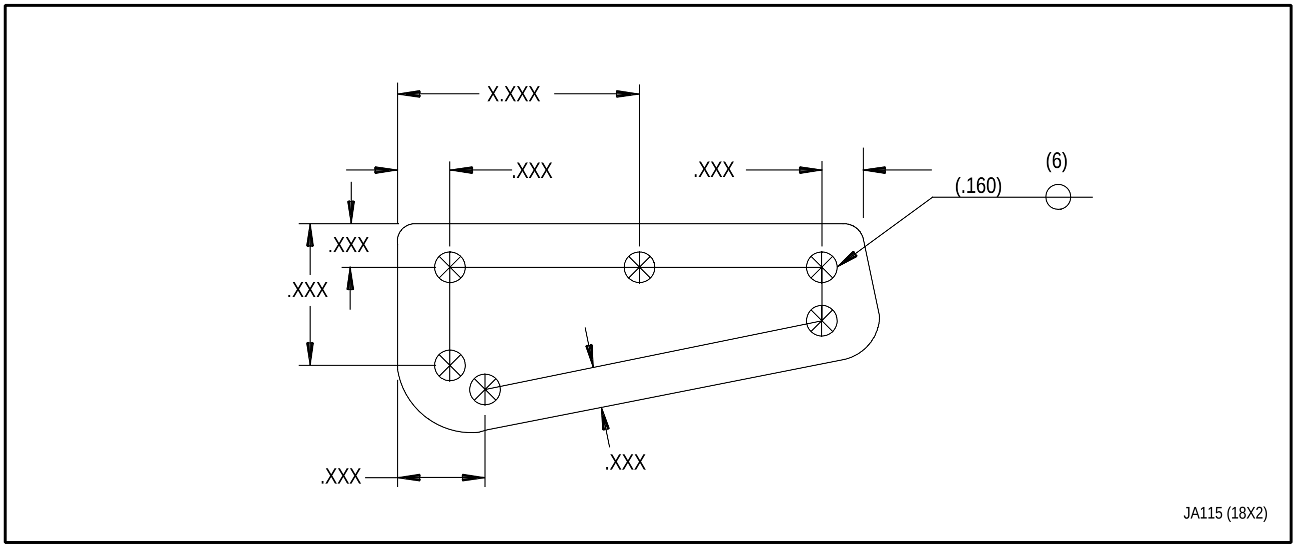


Figure 35. Spot Weld Location

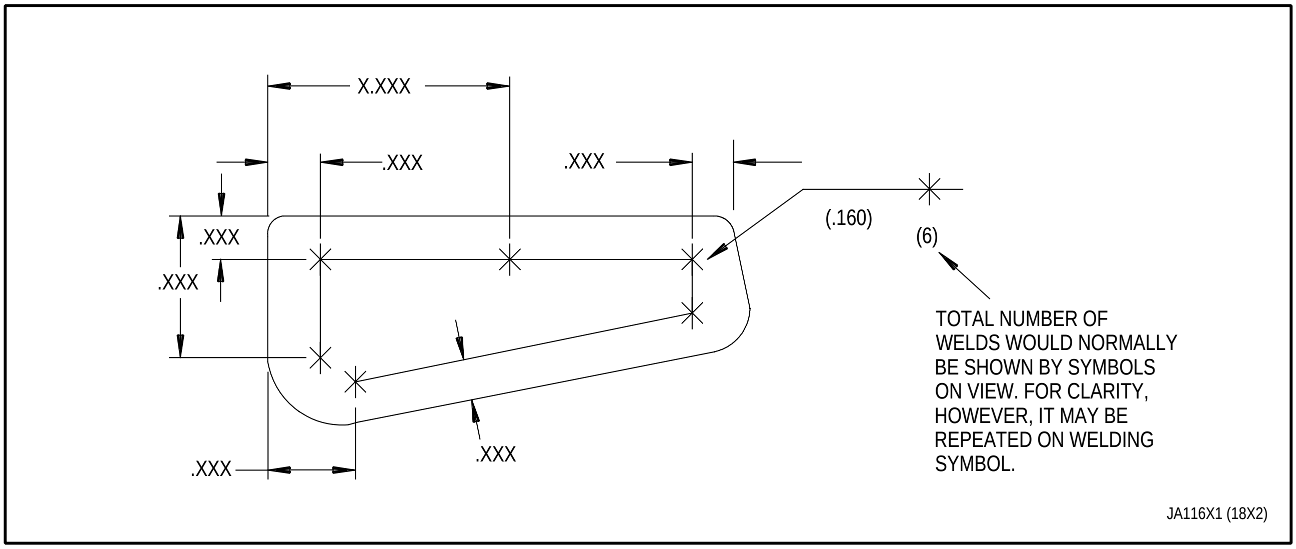


Figure 36. Discontinued Spot Weld Location

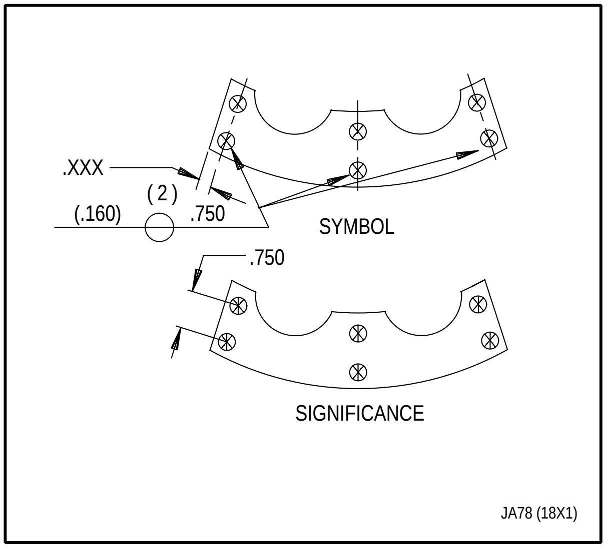


Figure 37. Multiple Arrows - Spot Welding

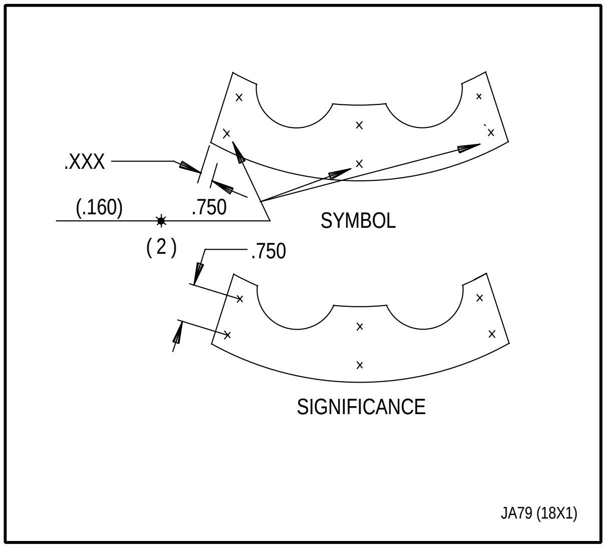


Figure 38. Discontinued Multiple Arrows - Spot Welding

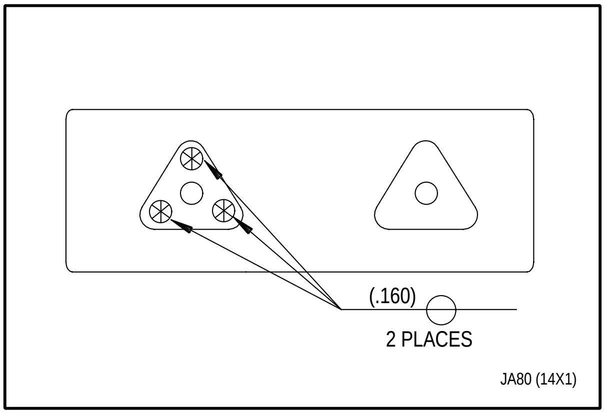


Figure 39. Multiple Arrows - Spot Welding

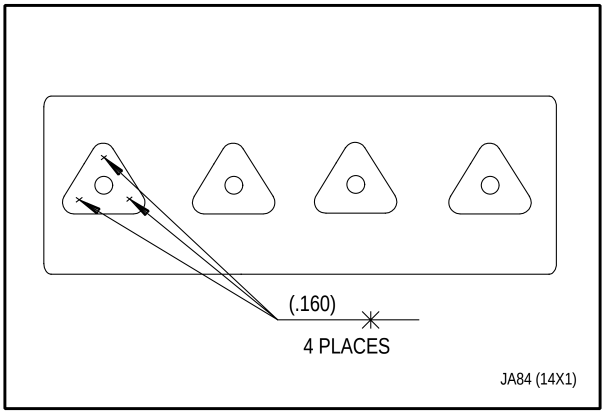


Figure 40. Discontinued Multiple Arrows - Spot Welding

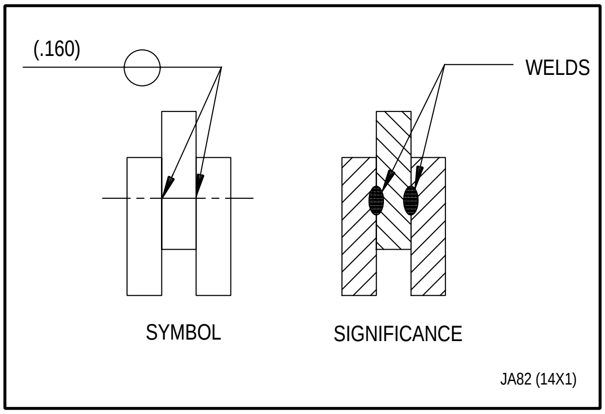


Figure 41. Multiple Arrows - Seam Welding

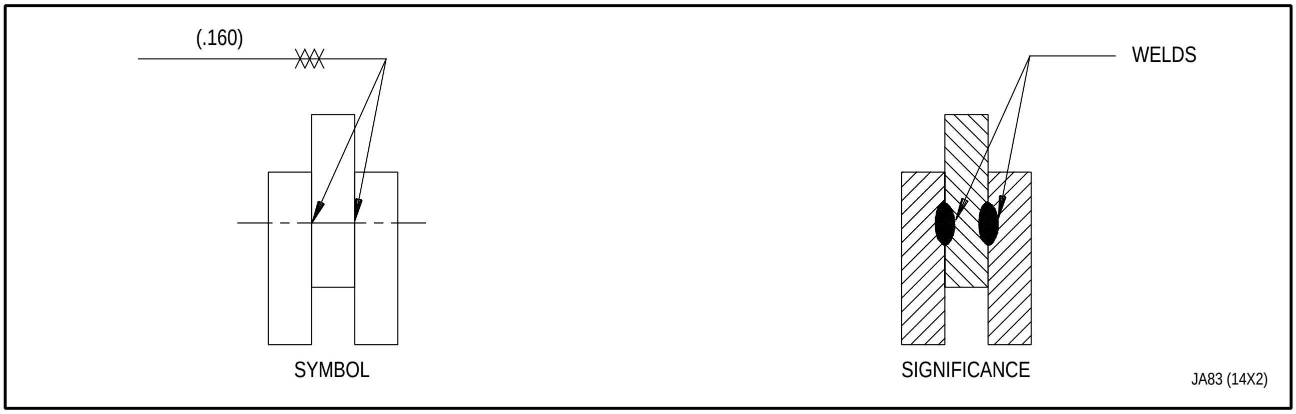


Figure 42. Discontinued Multiple Arrows - Seam Welding

16. OPTIONAL FUSION WELDS.
(See Figure 43.)

a. The option of welding from either side of a square-groove weld that joins equal thicknesses of material is indicated by placing the word OR in a break in REFERENCE LINE.

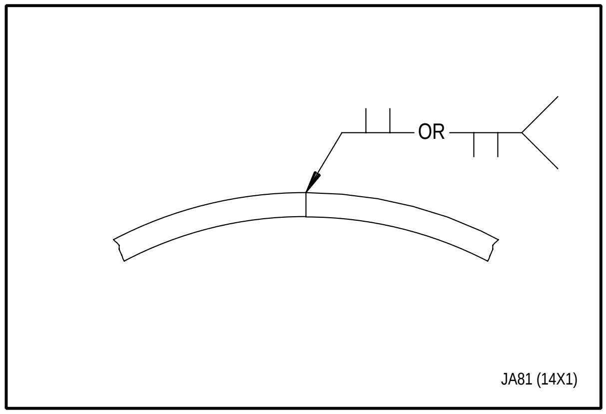


Figure 43. Optional Fusion Weld

17. COMBINATION WELDS.
(See figure 19 and Figure 44.)

a. Several forms of welds may be combined at a single joint. For example, a fillet weld may be added to a groove weld or grooves may be cut in from both sides of joint.

b. Where needed in COMBINATION WELDS, DIMENSIONS are shown above and below reference line as appropriate. Dimensions for symmetrical double welds, however, are given only once, usually below reference line.

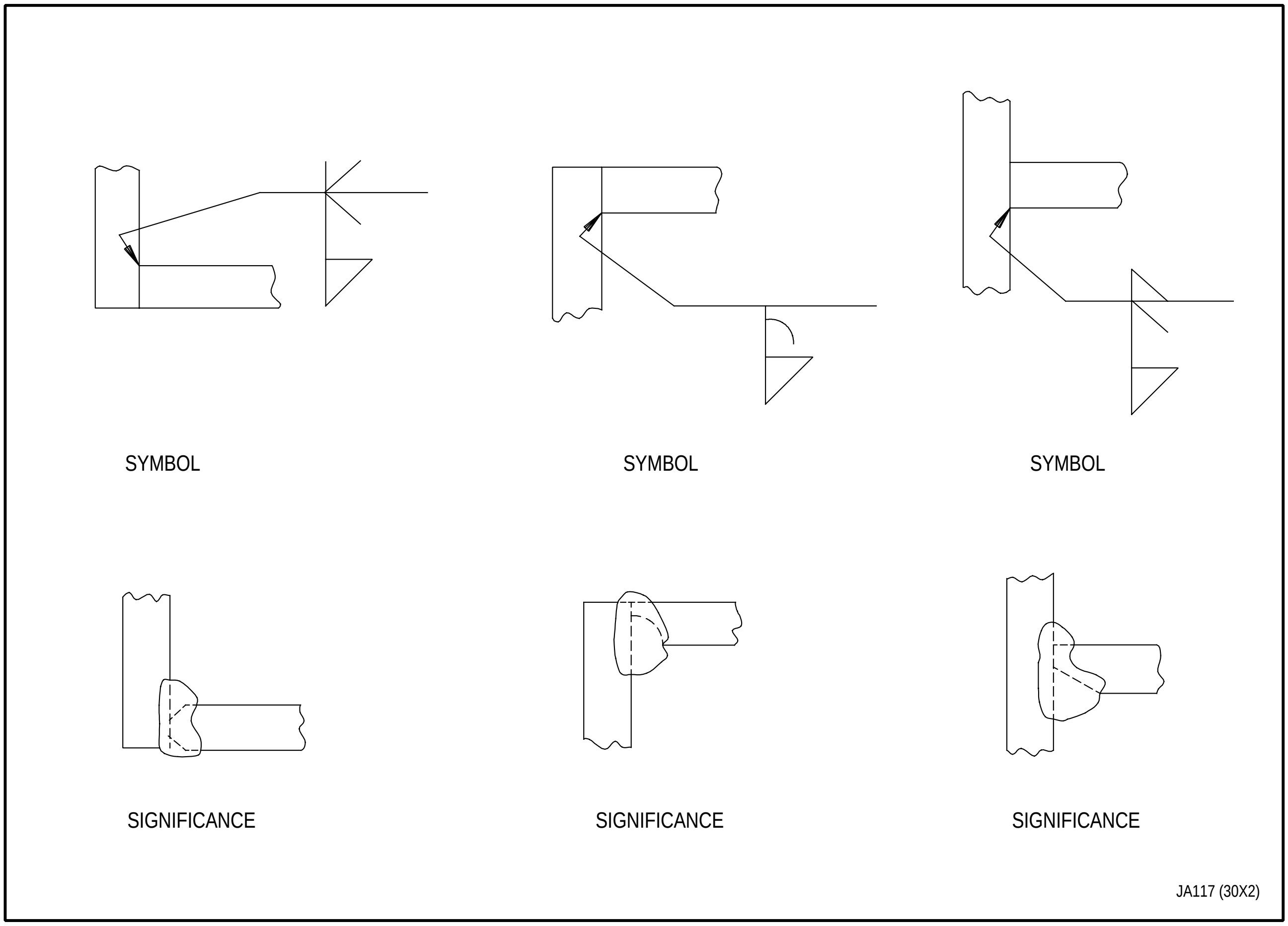


Figure 44. Combination Weld Symbols

18. FUSION WELD PREPARATION.

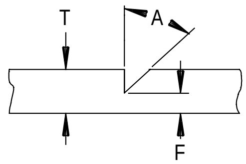
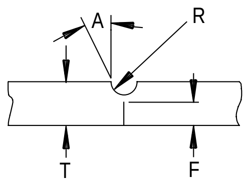
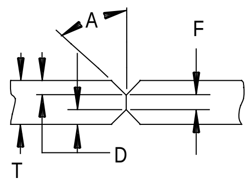
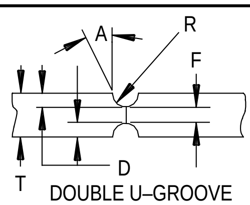
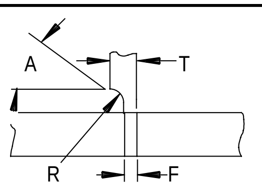
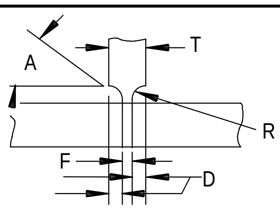
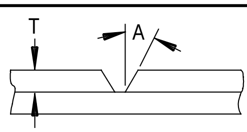
(See Tables 3, 4, and 5.)

a. Root face, bevel angle, radius, and depth of preparation for prepared welds for titanium shall be completed per table 3.

b. Root face, bevel angle, radius, and depth of preparation for prepared welds for materials other than titanium shall be completed per table 4.

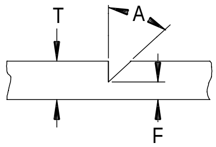
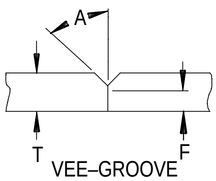
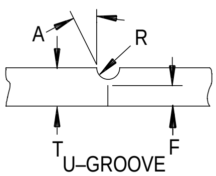
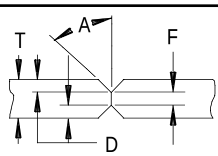
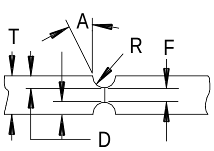
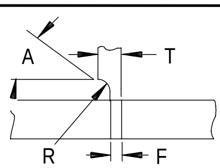
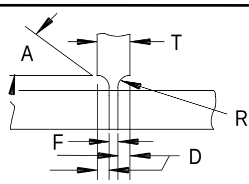
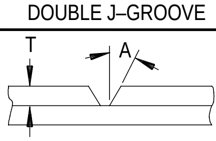
c. Root opening shall be as small as possible, but in no case greater than values listed in table 5.

Table 3. Root Face, Bevel Angle, Radius, and Depth of Preparation for Titanium

WELD TYPE	IF THICKNESS (T) IS:	ROOT FACE (F), INCH	BEVEL ANGLE (A), DEGREES	RADIUS (R), INCH	MINIMUM DEPTH (D), INCH
 BEVEL–GROOVE	0.125 INCH OR LESS MORE THAN 0.125 INCH	0.035–0.055 0.040–0.060	40–50 40–50	— —	— —
 U–GROOVE	—	0.060–0.090	10–20	0.078–0.108	—
 DOUBLE VEE–GROOVE	—	0.040–0.060	40–50	—	$\frac{T-0.090}{2}$
 DOUBLE U–GROOVE	—	0.040–0.060	10–20	0.078–0.108	$\frac{T-0.090}{2}$
 J–GROOVE	0.125 INCH OR LESS MORE THAN 0.125 INCH	0.030–0.050 0.040–0.060	25–35 25–35	0.047–0.077 0.078–0.108	— —
 DOUBLE J–GROOVE	—	0.040–0.060	25–35	0.078–0.108	$\frac{T-0.090}{2}$
 PLUG OR SLOT	0.090 INCH OR LESS MORE THAN 0.090 INCH	— —	NO BEVEL 55–65	— —	— —

JA85 (51X2)

Table 4. Root Face, Bevel Angle, Radius, and Depth of Preparation for Materials Other Than Titanium

WELD TYPE	IF THICKNESS (T) IS:	ROOT FACE (F), INCH	BEVEL ANGLE (A), DEGREES	RADIUS (R), INCH	MINIMUM DEPTH (D), INCH
 BEVEL–GROOVE	—	0.030–0.050	40–50	—	—
 VEE–GROOVE	0.125 INCH OR LESS	0.030 0.050	40–50	—	—
	MORE THAN 0.125 INCH	0.040–0.060	40–50	—	—
 U–GROOVE	—	0.040–0.060	10–20	0.078–0.108	—
 DOUBLE VEE–GROOVE	—	0.040–0.060	40–50	—	$\frac{T-0.090}{2}$
 DOUBLE U–GROOVE	—	0.040–0.060	10–20	0.078–0.108	$\frac{T-0.090}{2}$
 J–GROOVE	0.125 INCH OR LESS	0.030–0.050	25–35	0.047–0.077	—
	MORE THAN 0.125 INCH	0.040–0.050	25–35	0.078–0.108	—
 DOUBLE J–GROOVE	—	0.040–0.060	25–35	0.078–0.108	$\frac{T-0.090}{2}$
 PLUG OR SLOT	0.090 INCH OR LESS	—	NO BEVEL	—	—
	MORE THAN 0.090 INCH	—	55–65	—	—

JA86X1 (51X2)

Table 5. Root Opening Limits

Weld Type	Maximum Root Opening, Inch
Groove (Inert Gas Processes)	0.060
Groove (Electron Beam Process)	0.003
Arc Spot or Arc Seam (All Processes)	0.000

19. WELD IDENTIFICATION.

a. Identification such as stress-relief marking shall be applied by vibration peening but not deeper than 0.004 inch.

b. Electrolytic etch shall be used instead of vibration peening for parts thinner than 0.030 inch or for surfaces that move relative to contacting surfaces.

c. Weld marking shall be located either within an existing identification area, or within one inch of weld but outside heat discolored area.

d. Marking shall be closer to weld identified than to any other weld unless otherwise specified in WP/SWP.

e. Where special coatings are applied, special type and location of identification marking may be specified in WP/SWP.

20. INSPECTION OF WELDS.

a. Welder shall physically inspect welds for quality, uniformity, undercutting, or cracking, using a 10X magnifier.

b. Filler metal shall be blended into parent metal in gradual smooth curves. Under no conditions shall thickness of parent metal be reduced.

c. Special care shall be used when welding gaspath parts, to hold weld beads to minimum height, and to fair them by blending. Failure to observe this precaution could result in flow disturbance, and consequently reduce efficiency of engine operation.

d. Welds shall be sound, clean, free from foreign material, and free from defects (surface or subsurface) which could adversely affect strength of weld.

e. When welding near a hole, metal between weld area and edge of hole may begin to melt. This condition can result in a V-shaped area at edge of hole, and is called Melt Back. This is caused by lack of material to absorb heat of welding. If this occurs, add filler metal and restore hole and surrounding area to original configuration.

f. Tack welds shall not be injurious to parent metal, and shall not affect quality of final weld. Tack welds shall be completely contained within final weld, unless otherwise specified in WP/SWP.

g. Surfacing (hardfacing) welds shall show fusion at interface, and back (backing) welds shall have fusion at root of joint.

h. Plug and slot welds shall have fusion at all interfaces and depth of filling shall be complete.

i. Welds shall be free from excessive surface burning, or expulsion or spitting of molten metal, unless specifically permitted.

j. When two or more welds have identical symbols on illustrations, and comparable type and thickness of material, appearance shall be substantially uniform.

k. Inspect for stress cracks in weld metal and in metal adjacent to weld, by radiographic method. Refer to T.O. 33B-1-1. Visible contrast dye penetrant or fluorescent penetrant inspection, or equivalent, shall be used if X-ray equipment is not available.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, INERT GAS FUSION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 20

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 19	0				
20 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser(3)	SWP 031 01
Cleaning, Alkaline Rust Remover, Quick Soak(18)	SWP 031 08
Welding, Symbols, Preparation, Identification, and Inspection	WP 093 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, denatured	O-E0760
Alcohol, isopropyl	TT-I-735
Alcohol, methyl	O-M-232
Ceramic fiber, bulk	Fiberfrax
Tetrachloroethylene (Perchloroethylene)	O-T-236
Trichloroethane, 1,1,1-, inhibited	MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains general instructions for depot maintenance inert gas fusion welding. General welding information is given in T.O. 2J-F100-53-1, WP 093 00.

2. DIMENSIONS AND TOLERANCES FOR WELD THICKNESS.

(See Figures 1 and 2.)

a. The following standards apply unless otherwise specified in work packages/subordinate work packages.

b. Weld height for grooves welded from only one side, flanges with complete penetration, plug, slot, spot, and seam welds. Refer to figure 1 and T.O. 2J-F100-53-1, WP 093 00, table 2.

(1) When welding symbol does not include CONTOUR or FINISH symbols, height of weld above parent metal shall not exceed 100% of parent metal thickness for manual welding or 50% for machine welding. Depression below surface shall not exceed 5% of parent metal thickness.

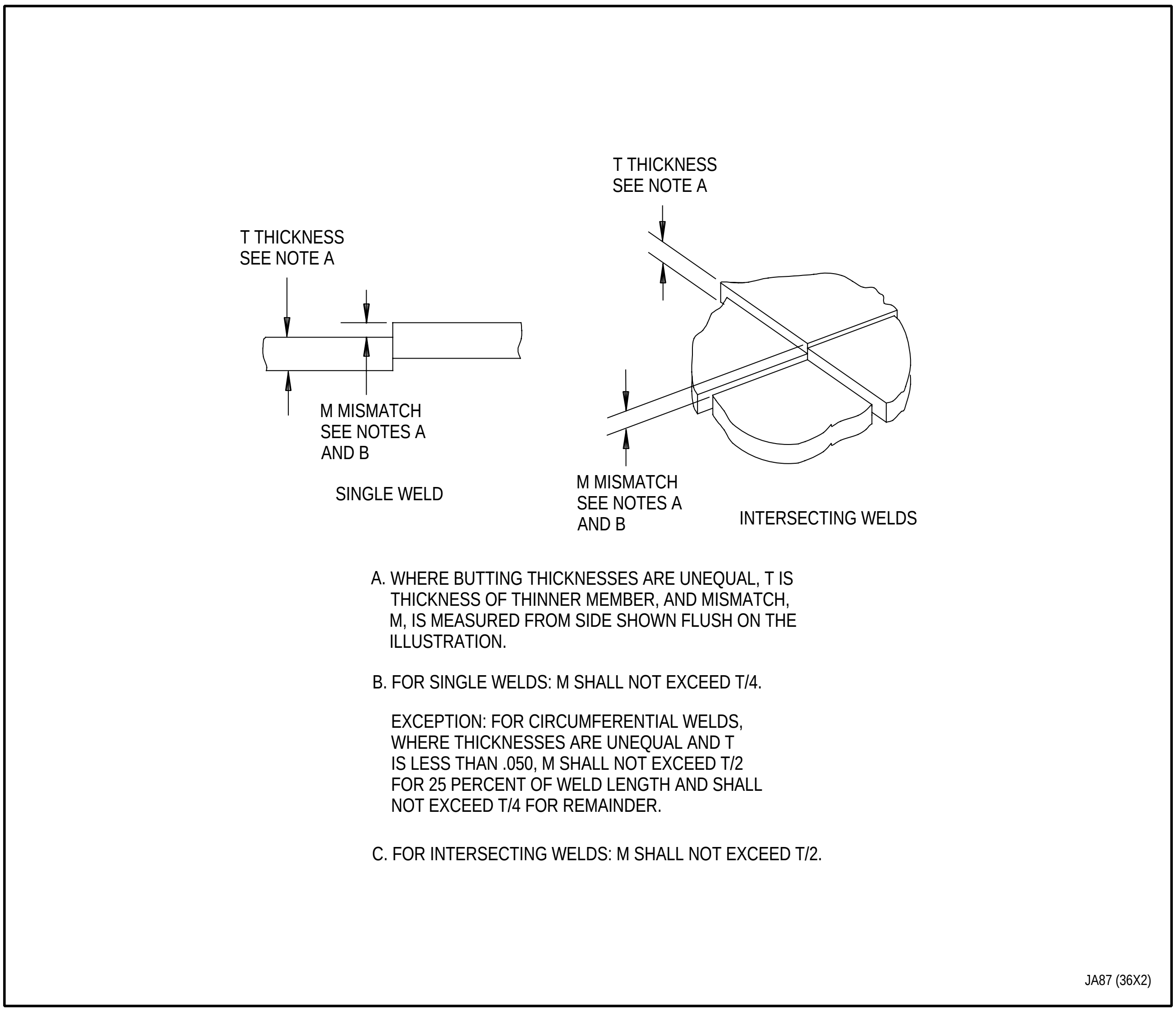


Figure 1. Mismatch Limits

(2) When welding symbol includes a CONVEX CONTOUR but not a FINISH symbol, maximum weld height above parent metal shall not exceed 100% of parent metal thickness for manual welding or 50% for machine welding, and shall be not less than 10%.

(3) When welding symbol includes a FLUSH CONTOUR but not a FINISH symbol, weld height tolerance shall be as specified per work packages/ subordinate work packages.

(4) When welding symbol includes FLUSH CONTOUR and FINISH symbols, height of weld above parent metal after finishing shall be not more than 0.010 inch. Total thickness of welded joint after finishing, not including melt-through, shall be not less than minimum thickness of parent metal.

c. For machine weld without FINISH specified, total thickness of welded joint shall not exceed 175% of parent metal.

d. For groove welds at both sides of parent metal, weld height above each face shall conform to limits of paragraph 2.a. separately.

e. When groove weld is on one side, and back (backing) weld at other side, standard dimensions and tolerances apply to the groove weld per paragraph 2.a.

f. Back (backing) welds.

(1) Without FINISH specified, minimum size shall be as specified per work packages/ subordinate work packages.

(2) Unless otherwise specified in work packages/subordinate work packages, maximum for bead less than 0.188 inch shall be 2.0 times that of minimum.

(3) Maximum for bead more than 0.188 inch shall be 1.5 times that of minimum.

(4) When FINISH is specified, weld height after finishing shall be not more than 0.010 inch.

(5) Thickness of welded joint after finishing, not including weld at side where deposited, shall be not less than minimum thickness of parent metal.

g. When different thicknesses of metal are joined, percentage tolerances are based on thickness of thinner member, measured from surface of thinner member.

h. Mismatch.

(1) Unless otherwise specified in work packages/subordinate work packages, mismatch shall not exceed 25% of thickness of the thinner of pieces being joined, as illustrated in figure 1.

- Exception: If thinner piece is less than 0.050 inch thick, mismatch for up to 25% of length of weld may be up to 50% of thickness of the thinner piece.

(2) When different thicknesses are welded, measure mismatch from side which is flush; or, if neither side is flush, measure from centerlines of members being joined.

(3) Mismatch at weld intersections shall not exceed 50% of thickness of thinner member.

(4) Total thickness of welded joint shall not be less than thickness of thinner member.

(5) Mismatch may be determined after fixturing or tack welding, and before final welding.

i. Melt-through. The following requirements apply to groove welds except flare-groove welds, and flange welds, except where complete penetration is not required. If FINISH is specified, these requirements apply after finishing. If FINISH is not specified, these requirements apply to metal as welded.

(1) Melt-through refers to welded metal on back side of parent metal opposite where weld was deposited.

(2) When no CONTOUR or FINISH symbol appears, height of melt-through shall be not more than 50% of parent metal thickness.

(3) When CONVEX CONTOUR but not FINISH is specified, height of melt-through shall not exceed 50% of parent metal thickness, and it shall have a convex contour.

(4) When FLUSH CONTOUR but not FINISH is specified, height limits of melt-through shall be specified in work packages/subordinate work packages.

(5) When FLUSH CONTOUR and FINISH are specified, height after finishing shall be not more than 0.010 inch. After finishing, welded joint not including deposit on side welded, shall be not less than minimum thickness of parent metal.

(6) Melt-through on corner-joint square-groove welds is acceptable if height of melt-through, measured from each member, is not greater than 150% of thickness of thinner piece.

j. Size of fillets in fillet welds.

(1) A fillet weld LEG is defined as the distance from root of joint (point of nearest approach of weld members) to edge of weld deposit, except in the case of a lap joint fillet weld. For a lap joint, fillet weld LEG may be measured from either root of joint, or from root of the weld to edge of weld deposit. LEGS are usually at right angles to each other, and usually equal.

(2) A fillet weld THROAT is defined as a line from root of joint perpendicular to a line connecting the two edges of the weld deposit, for a fillet with a convex or flush surface. LEG and THROAT for a convex fillet are illustrated in figure 2, View A. Length AB represents on LEG, and AC represents the THROAT. Equal legs are assumed in this illustration.

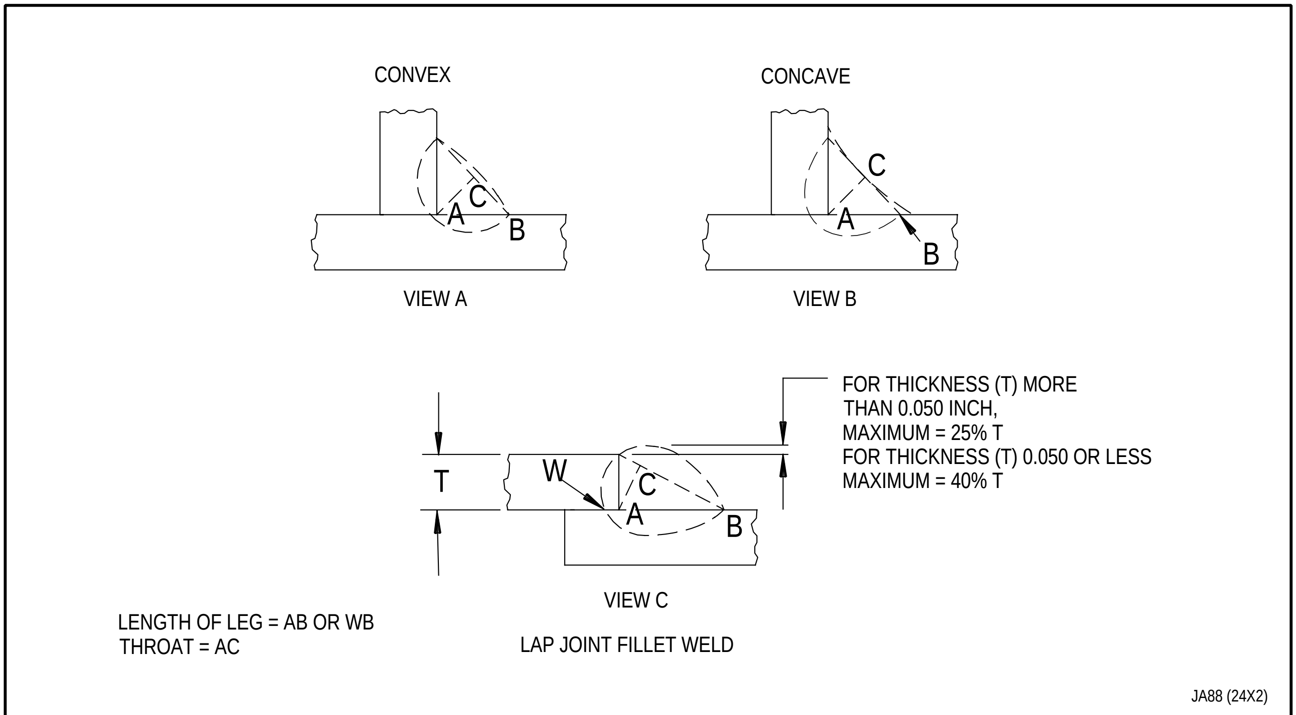


Figure 2. Size of Fillets in Fillet Welds

(3) For a fillet with a concave surface, the THROAT extends from root of joint, perpendicular to a line tangent to the concave profile. LEG and THROAT for a concave fillet are illustrated in figure 2, View B. Length AB represents on LEG, and AC represents the THROAT.

(4) THROAT shall be not less than 0.5 multiplied by length of LEG specified in work packages/subordinate work packages for titanium parts, or not less than 0.7 multiplied by length of LEG specified in work packages/ subordinate work packages for parts other than titanium. If LEGS are unequal, use shorter leg to determine THROAT size.

(5) In a lap joint fillet weld, convex deposit shall not extend higher than 25% of parent metal thickness more than 0.050 inch, or higher than 40% of parent metal thickness 0.050 inch or less. LEG and THROAT for a lap joint fillet are illustrated in figure 2, View C. LEG is represented either by AB or WB, and the THROAT is represented by AC.

(6) Length of fillet weld LEGS shall be not less than size specified in work package/ subordinate work packages. Maximum length shall be not more than 3.0 multiplied by specified size for fillets 0.063 inch or less; 2.0 multiplied by specified size for fillets 0.063 inch through 0.187 inch; or 1.5 multiplied by specified size for fillets 0.188 inch or more.

k. Size of flange welds when FINISH not specified.

(1) Minimum size of weld deposit shall be as specified per work packages/subordinate work packages.

(2) For size of weld deposit less than 0.188 inch, maximum shall be 2.0 times specified size.

(3) Unless a different maximum size is specified per WP/SWP for size of weld deposit 0.188 inch or larger, maximum shall be 1.5 times specified size.

l. Length of welds.

(1) When weld length specified in work packages/subordinate work packages is 0.500 inch or less, length shall be within plus or minus 30% of length specified.

(2) When weld length specified in work packages/subordinate work packages is more than 0.500 inch, tolerance for length shall be minus 0.000 to plus 0.250 inch.

m. Pitch of intermittent welds. Pitch (center to center spacing) of intermittent welds shall vary not more than plus or minus 0.060 inch from value specified by work packages/subordinate work packages.

n. Melt-through for flare-groove welds. Buildup on side opposite from which weld was deposited shall be kept to minimum.

o. Positioning spot and seam welds.

(1) Weld centers shall be centered on overlap, or located as required per work packages/subordinate work packages, with a tolerance of plus or minus 0.040 inch. Weld center shall be considered as one-half the weld width from edge of weld.

(2) Distance from edge(s) or piece(s) perpendicular to end of welding line shall be within plus or minus 0.040 inch of distance required by repair illustration in work packages/subordinate work packages.

3. INERT GAS FUSION WELDING.

(See Tables 1 and 2.)

a. General.

(1) Inert gas fusion welding is an arc process using an inert gas such as helium or argon to protect the weld area from oxidizing (burning).

(2) One type of inert gas welding is called TIG (tungsten/inert gas). In TIG welding, the tungsten electrode is not consumed, and filler metal such as welding wire or rod is added (fed) into the weld area. Most alloys are welded using a thoriated tungsten electrode (tungsten combined with 2% thorium oxide). Aluminum and magnesium are welded using a pure tungsten electrode. Magnesium is welded with alternating current (AC), and aluminum with either AC or direct current (DC). Special procedures for welding magnesium are given in T.O. 2J-F100-53-1, SWP 093 04.

(3) A second type of inert gas welding is called MIG (metal/inert gas). In MIG welding, the metal electrode becomes the filler metal, and is consumed as it is fed into the weld area. Generally an electrode is selected having the same composition as the material being welded. The MIG method shall be used only when specified by work packages/subordinate work packages.

(4) Either TIG or MIG may be used manually or by the machine (automatic) method.

(5) Electrodes or welding wire or rod which is coated with a flux sheath is not authorized for Depot Maintenance engine repair.

(6) The American Welding Society (AWS) process codes for fusion welding methods are listed in table 1.

dpgbrKa

Table 1. FUSION WELD PROCESS CODES Machine Gas Tungsten Arc

Weld Process	AWS Letter Designation
Manual Gas Tugsten Arc (TIG)	GTAW-MA
Machine Gas Tungsten Arc (TIG)	GTAW-ME
Manual Gas Metal Arc (MIG)	GMAW-MA
Machine Gas Metal Arc (MIG)	GMAW-ME
Electron Beam*	EBW
Manual Plasma Arc (Transferred Arc)	PAW-MA
Machine Plasma Arc (Transferred Arc)	PAW-ME
*Fusion welding in a vacuum rather than in an inert gas.	

(7) The most common method for repairing actual cracks in jet engine parts is TIG. In some cases, electron beam welding is used for part replacement or adding a section to a part. For electron beam welding, refer to T.O. 2J-F100-53-1, SWP 093 02, and for plasma arc welding, refer to T.O. 2J-F100-53-1, SWP 093 03.

b. Welding atmospheres.

(1) Permissible shielding gas atmospheres for TIG and MIG processes are shown in table 2.

Table 2. Welding Atmospheres

Weld Process	Group A: Titanium (Note 1) or Refractory Alloys (Note 2)	Group B: Alloys other than Group A	Nickel or Cobalt Alloys	Low Alloy Steel	Nonprecipitation Hardenable Steel
TIG (GTAW-MA or GTAW-ME)	Argon and/or helium: minimum purity, 99.998%; maximum free oxygen, 2.5 ppm; maximum water (vapor), 10 ppm (Note 3)	Argon: minimum purity, 99.995% or Helium: doubly-charcoal-refined grade	Same as Group B	Same as Group B	Same as Group B
MIG (GMAW-MA or GMAW-ME)	Same as for TIG	Same as for TIG	Same as Group B or Argon + maximum of 2% hydrogen	Same as Group B or carbon dioxide	Same as Group B or Argon + maximum of 5% oxygen

NOTE

(1) Special procedures for welding titanium are given in T.O. 2J-F100-53-1, SWP 093 05.

(2) Includes C-103 columbium alloy and thoria-dispersed (TD) nickel.

(3) Unless permitted otherwise, per package/subordiate work packages.

(2) When welding in the open, argon is preferable to helium since argon is heavier, and does not dissipate as rapidly. In an enclosure, such as a chamber or a durable clear plastic envelope, either argon or helium is satisfactory. MIG welding is not normally done in an enclosure.

(3) The high temperatures of fusion welding result in a tendency toward increase of hardness, reduction of ductility, and cracking in weld zone following air cooling. This tendency is reduced or eliminated by a post-welding stress-relief heat treating cycle, which is required for most materials. The particular cycle is usually specified in work package/ subordinatework package.

c. Equipment for TIG and MIG inert gas fusion welding.

(1) Ventilation equipment as required.

WARNING

Installing a regulator contaminated with oil or grease on an oxygen tank can result in an explosion when the oxygen mixes with the contaminant. Do not install any regulator onto an oxygen tank if the regulator has been used with any other type gas.

(2) Appropriate gas regulators and flowmeters.

(3) Inert gas enclosure fixtures. In some cases, a durable clear plastic envelope may be used.

CAUTION

To prevent contamination, all weld tooling (backup bars, expandable backup shoes and hold-down clamps) made of copper, used for the welding of cobalt or refractory alloys shall be chromium or nickel plated. Plate shall cover all areas of tool that may contact part during assembly or welding.

(4) Fixtures and chills. A chill is a type of heat sink, usually in the form of a metal bar fastened against a weld member to conduct away excess heat.

d. Equipment for TIG inert gas fusion welding.

(1) Miller SR-200 DC or AC/DC Welder, or Airco DC or AC/DC 200 ampere Bumblebee Welder, or equivalent.

(2) Linde HW-9 (pencil-type), or equivalent hand-operated TIG gas-cooled torch.

(3) Linde HW-20, with water circulating equipment and ceramic cups ranging from No. 5 to No. 8, or equivalent hand-operated TIG water-cooled torch.

(4) Linde HW-13, or equivalent machine TIG water-cooled torch.

e. Equipment for MIG inert gas fusion welding.

(1) Airco DC Aircomatic Welder, or equivalent.

(2) Aircomatic AH20 or AH35 gun, or equivalent.

(3) Airco wire feeder, or equivalent.

(4) Linde ST-12, or equivalent machine MIG torch.

f. Preparation for inert gas fusion welding.

CAUTION

Impurities will weaken welds.

(1) Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

CAUTION

Wire brushes used for cleaning corrosion and heat resistant steels and alloys shall have bristles of austenitic corrosion resistant steel. When using wire brushes, ensure that undesirable surface materials are removed, not merely polished over.

(2) Wire brushes or silicon carbide abrasives may be used for rough removal of protective coatings, dirt, and surface scale. If aluminum oxide abrasive is used for rough cleaning certain alloys such as Type 410 steel when permitted by work package/subordinate work package, it shall be followed by cleaning with silicon carbide abrasive. If necessary, parts may be given a quick alkaline soak cleaning per T.O. 2J-F100-53-1, SWP 031 08. For final surface cleaning and oxide removal, use only silicon carbide abrasives, followed by solvent rinse. Authorized solvents are described in following paragraphs.

(3) The only solvents authorized for cleaning titanium alloys are O-A-51 acetone and TT-I-735 isopropyl alcohol. If none are available, wipe parts to be welded and the filler metal with a clean, white cloth.

CAUTION

The following solvents shall not be used on titanium alloys.

(4) Solvents which may be used to clean weld members and filler materials composed of alloys other than titanium before welding include O-T-236 tetrachloroethylene (perchloroethylene), MIL-T-81533 trichloroethane, O-M-232 methanol, or O-E-760 denatured alcohol.

(5) Solvents authorized for titanium (acetone, and isopropyl alcohol) may be used on other alloys; however, tetrachloroethylene (perchloroethylene) and trichloroethane are usually preferred because they are nonflammable.

(6) Carefully remove any trace of copper as a contaminant on surface of cobalt alloys before welding, if any previous metal-working operation using copper or brass tools or fixtures resulted in such contamination.

(7) Remove all plasma or flame spray, Linde Flame Plate, or any other plate or coating in weld area. These substances would weaken welds. This is especially important when welding near a coated area even when region to be welded is thought to be bare, since overspray may have been permitted.

(8) No cleaning deposit or residue shall remain on parts or pieces to be welded.

(9) Prepare joints when grinding or machining preparation is specified in work package/ subordinate work package per welding symbol. Refer to T.O. 2J-F100-53-1, WP 093 00.

g. General inert gas fusion welding procedures.

WARNING

Brazing and welding operations produce fumes that can be harmful to breathe. Arc welding emits ultraviolet light, which can burn skin and eyes. Provide adequate ventilation. Wear protective clothing.

CAUTION

When TIG welding engine parts, electrical ground connection from welding equipment shall be attached directly to part being welded. Under no circumstances may ground connections be attached so that current could flow through engine from one part to another.

(1) In TIG welding, if a sealed welding chamber (either rigid or flexible) is used, cups need not be used around electrode nor are backup fixtures necessary, provided chamber has been thoroughly purged of all air atmosphere and contains only an inert gas.

(2) Connect appropriate gas flowmeters to torch and backup shield, if used.

NOTE

A pure or thoriated tungsten electrode may be used; however, when high frequency controls are not available, a needle point shall be maintained on electrode for more positive starting of arc. Where practical, electrode shall be kept clean of material pickup.

(3) For TIG welding, install a suitable diameter electrode in torch, allowing approximately 0.312 inch of point to extend out of ceramic cup. Size of ceramic cup controls amount of inert gas flow to weld area.

(4) Select amount of gas pressure sufficient for adequate backup, but not so much as to agitate weld puddle while in fluid condition. A vent may be required to purge interior of fixture, to prevent weld contamination.

(5) On sheet metal parts having a thickness of 0.010 to 0.090 inch, weld backup tape may be used instead of gas backing, where gas backing would be difficult to apply.

(6) For TIG welding, gas backing is necessary at underside of weld, whenever it could be exposed to atmosphere, or a poor quality weld will result, with typical contamination and porosity. Where such gas protection is required, attach argon gas line in back of crack to be welded. This may be done by fabricating small boxlike fixtures having edges shaped to fit contours of part to be welded and using a Victor 50-20 Argon Connector, or equivalent, to secure line. Seal fixture to part in order to conserve as much inert gas as possible. On some hollow parts, such as inlet guide vane assemblies or diffuser cases, openings may be sealed and entire inner area purged with inert gas.

NOTE

Test welds, using similar materials of same thickness and joint design, shall be made to determine settings required.

(7) In TIG welding, if high frequency controls are not available, strike arc on a copper plate adjacent to weld area to prevent arc damage to part. Hold tip of electrode approximately 0.125 to 0.250 inch above surface to be welded until puddle forms. Add welding wire (filler metal), and weld part(s).

(8) In manual TIG welding, when high frequency controls are available, it is not necessary to strike an arc. Hold torch vertically in relation to workpiece, so that shielding gas will form a protective envelope around weld. It is preferable to have area to be welded in a horizontal (flat) position.

(9) Do not use flux when welding in an inert atmosphere.

(10) When specified by work package/subordinate work package, pack weld area with wet bulk ceramic fiber for cooling purposes.

h. Cleaning after inert gas fusion welding.

(1) Clean out holes with rotary file and polish with No. 180 abrasive cloth.

(2) Remove oxides and discoloration caused by welding, using methods described for precleaning, paragraph 3.f.(1) through 3.f.(5), as applicable.

4. APPLICATION OF FUSION WELD-TYPE HARDFACE.

NOTE

- Inert gas fusion welding procedure and techniques will help prevent contamination of weld when applying hardface.
- Hardface shall be applied in thin layers, in order to obtain maximum hardness and minimum dilution of hardface material with parent alloy.

a. Select smallest diameter practicable of hardface weld wire, such as Stellite 1016, and set machine for alternating current. Use minimum heat, and do not dwell at one spot longer than necessary.

b. Using small, narrow beads, apply thin layer of hardface to seal area. Restrict arc and melting to overlay material only, rather than to parent alloy, as much as possible. Grind off approximately 50% of first layer, to eliminate diluted portion, which would have a reduced hardness.

c. Using small, narrow beads, apply second thin layer of hardface over initial layer. If penetration is kept to minimum, second layer will be harder than first layer. Grind off approximately 50% of this new layer.

d. Apply a third layer in similar manner, to obtain desired buildup. Dilution is now minimized.

e. Clean and inspect hardface. Finish by machining as directed per work package/subordinate work package for particular part.

5. PATCH-TYPE WELD REPAIRS.
(See Figure 3.)

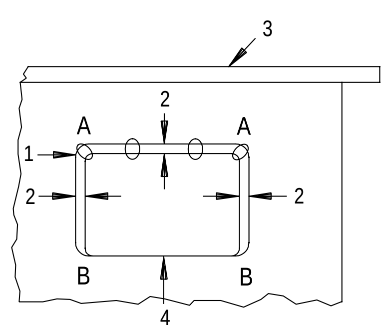
a. In order to minimize distortion when making patch-type weld repairs, be sure to employ two principles. First, use a close fit between patch and cutout in part. Second, use a small diameter weld rod. Within reasonable limits, a smaller gap results in less distortion. A small weld rod requires substantially less heat, which also helps to minimize distortion. More than one pass may be required when using a small weld rod, and this is acceptable.

b. Proper use of these principles is most important when an adjacent flange or surface incorporates a critical tolerance. The nearer a patch repair is located to a critical area of flatness, squareness, parallelism or concentricity, and the smaller the tolerance involved, the more important these principles become. Patches located further away from such an area, and areas with greater tolerances, require less attention to these two principles.

c. The sequence of welding patches into place can also influence distortion. Figure 3 shows a typical weld repair patch and the following procedure shall be used for such repairs:

(1) Cut out area of part needing repair, using well-rounded corners.

1. TACK WELD.
2. USE SMALL GAP. THE SMALLER THE GAP, THE LESS THE DISTORTION.
3. FLANGE OR CRITICAL AREA.
4. NO INITIAL GAP.



JA89 (24X2)

Figure 3. Patch-type Weld Repair

(2) Make patch of proper material and thickness, and preharden patch to match hardness of part. Shape part to proper contour, if necessary. Use well-rounded corners to match radius of cutout.

(3) Maintain small gap. When a very close fit is desired, trim small amount of patch as it is placed into position. Use trial and error trimming sequence to obtain desired fit. A line-to-line fit gives minimum distortion.

(4) Install patch in place as in figure 3.

(5) Tack weld along edge nearest flange or other critical surface in a few spots. Maintain an even gap along three sides as shown. Side of patch away from critical area shall have no gap initially.

(6) Weld along edge from A to A. Patch will tend to move toward weld creating a gap along side B-B.

(7) Weld from A to B in short distances alternating from side to side.

(8) Finally, weld from B to B.

(9) Inspect weld and part for proper dimensions and distortion.

6. SKIP WELDING.

NOTE

In certain cases, skip welding is not recommended. An example is that of welding projections on a circular part, where there is a space between each projection. Skip welding could result in more distortion in this case, since heat is lost quickly, and fast heating and cooling results in warpage. Consecutive welding is preferred, as it permits next area to preheat, and it slows down cooling rate of previously welded area.

a. Skip welding is the technique of staggering weld locations, in order to minimize heat, and therefore distortion.

b. Generally, skip welding consists of welding a short distance in one location, then welding in a location 180 degrees away. The third weld is then made 90 degrees from the first, followed by the fourth weld 180 degrees from the third.

c. Subsequent welds are then made between any two existing welds, followed by a weld 180 degrees away, and so on, as before.

d. This pattern is continued until weld is complete.

e. Allow some time between welds so as to keep heat to minimum.

f. Information on repairs of specific parts may specify skip welding, and when experience indicates a particular skip weld pattern is desirable, it will be so outlined in work package/ subordinate work package.

7. WELDING NEAR FLANGES.

a. Welding near a flange frequently results in distortion of flange. Most often, flange is drawn toward weld.

b. In many cases, this condition can be minimized by using a welding fixture which allows flange to be secured to fixture. The fixture shall be flat, and strong enough to retain its shape under considerable pressure.

c. Before welding, measure flange for flatness, and determine location and amount of existing deviations.

NOTE

Do not attempt to prestress flange more than 0.020 inch in any 8 inch distance, or more than 0.060 inch in a distance of 24 inches. Maximum total thickness of shims is 0.060 inch.

d. When fixturing part for welding, shims may be placed between fixture and flange, to stress flange in opposite direction sufficiently so that, when welding is finished and part released, flange area near weld will tend to return to true position.

e. Welding near a flange can also affect the concentricity and roundness of a flange. As a general rule, flanges which are secured to a welding fixture with a mating diameter which provides a tight fit with the flange diameter, or an adjacent diameter, will tend to retain their shape with a minimum of distortion.

f. Welding fixtures shall also have considerable mass, in order to act as a heat sink, and draw off as much heat as possible.

g. When welding in a local area near a flange, bulk ceramic fiber may also be placed around the weld area to help absorb heat.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, ELECTRON BEAM

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 7	0	8 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser(SPOP 3)	SWP 031 01
Cleaning, Carbon Solvent and Paint Stripper, Two Step (SPOP 7)	SWP 031 04
Welding, Symbols, Preparation, Identification, and Inspection	WP 093 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, isopropyl	TT-I-735

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance electron beam welding.

2. GENERAL.

a. In an electron beam (EB) welding machine, electrons are brought to a speed of more than 90,000 miles per second in the electron gun. Using electrical and magnetic fields, the stream of electrons is focused into a narrow beam, which is directed at the part being welded.

b. When the high-speed electrons are stopped by the part being welded, their energy changes to heat, and melts the material in a small spot, to form a fusion weld. This process is done in a high vacuum, since air or gas would prevent the electrons from staying in a beam.

c. Two types of EB welders are available: low voltage, and high voltage. The low voltage machine uses 15,000 to 30,000 volts, and the high voltage machine uses 70,000 to 150,000 volts. Somewhat better focusing and penetration may be obtained with the high voltage-type.

d. An EB welding machine comprises two main systems: the electron gun, and the vacuum chamber. The electron gun system includes the electrical controls, and the vacuum chamber includes the pumping system of several stages.

e. In the low voltage-type machine, the workpiece (parts being welded) remains stationary, and the electron gun is moved into position, inside the vacuum chamber.

f. In the high voltage-type machine, the workpiece moves on a remotely controlled table, while the electron gun is mounted in an immovable position.

g. In both low voltage and high voltage machines, rotary heads may be used.

h. EB welding has the following advantages over tungsten inert gas (TIG) welding:

(1) Lower heat. Since the electron beam is tiny compared to a gas-arc, less total heat means less distortion of the part being welded.

(2) Better control. The electron beam can be precisely controlled by electric current and voltage, so that size and direction of the beam can give exactly the desired bead height and shape on certain materials.

(3) Greater purity. The high vacuum of EB welding means absence of all traces of oxygen or other contaminants. Also, whatever impurities are in the metal part or filler, are vaporized and pumped away in the vacuum.

i. Requirements for types of welds and inspection standards are generally similar for EB, as for TIG welding. The most common EB weld is the butt joint, since it can be done with little or no gap separating the parts. Usually the maximum gap before EB welding is 0.003 inch. Plug welds may also be done with EB welding.

j. Fillet metal may or may not be used. If it is used, it is usually in the form of a piece of metal with identical composition as the parent material, fastened before welding, over or under the joint and in firm contact. Filler metal may be wire, strip stock, or excess material which is part of the piece before welding, such as a snap or pilot diameter. The extra material is sometimes used to hold the parts in correct position, and then is consumed into the weld. If filler metal is used, finishing is usually required after welding, to remove the excess.

k. EB welding cannot automatically be used in place of TIG welding in all cases.

l. Conditions which could produce unsatisfactory EB welds would include misalignment or lack of focus, resulting in lack of penetration, or missing the joint partially or completely. Extreme care shall be used to avoid these conditions.

3. PREPARATION FOR EB WELDING.

CAUTION

Impurities will weaken welds.

a. Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e. Surface to be welded shall be free from dirt, grease, or oil.

CAUTION

Wire brushes used for cleaning corrosion and heat resistant steels and alloys shall have bristles of austenitic corrosion resistant steel. When using wire brushes, ensure that undesirable surface materials are removed, not merely polished over.

b. Wire brushes or silicon carbide abrasives may be used for rough removal of protective coatings, dirt, oxides, and surface scale. Remove all plasma or flame spray, Linde Flame Plate, or any other plate or coating in weld area. These substances would weaken welds. Silicon carbide abrasives shall be used for final surface cleaning and oxide removal.

CAUTION

- Do not use chloride-containing solvents on any parts.
- Any weld preparation of titanium parts involving water rinses, such as acid cleaning, shall include a final rinse with water having less than 50 ppm total dissolved solids, and less than 10 ppm chloride.

c. Solvent rinse, using, in order of preference, TT-I-735 isopropyl alcohol or O-A-51 acetone.

d. No cleaning deposit or residue shall remain on parts or pieces to be welded.

e. Prepare joints with minimum gap. Gap shall not exceed 0.003 inch. Machining before welding may be required.

f. Welding wire filler can usually be positioned at surface of joint. In some cases, strip stock of proper composition may be required to fill a joint. In such a case, strip stock shall be very thin, and carefully fitted to joint to be welded.

g. Final cleaning preferred for aluminum parts immediately before EB welding is T.O. 2J-F100-53-1, SWP 031 04, omitting the final corrosion preventive compound dip.

4. GENERAL ELECTRON BEAM WELDING PROCEDURES.

a. Unless otherwise described in WP/SWP, weld symbols and terminology for EB welding shall be in accord with that for other types of fusion welding. Refer to T.O. 2J-F100-53-1, WP 093 00.

NOTE

Flux is not used in EB welding.

b. Fixture parts, or clamp together with filler material (if used), as necessary.

c. Parts may be carefully tack welded together by inert gas fusion welding, using proper filler rod. Such tack welds shall not be injurious to part being welded, and shall not interfere with EB weld. Tack welds shall be completely contained within final weld, unless otherwise permitted by WP/SWP.

d. Install spatter shield, composed of same material as part being welded, behind rear of weld. Shield will catch molten spatter, and protect equipment and other areas of parts being welded.

NOTE

A reference file of all EB repair schedules shall be kept. Schedules shall be developed on scrapped or test parts of similar composition and configuration, before use on flight-qualified parts.

e. Adjust welding machine for proper beam power, spot size, and weld path. Follow manufacturer’s instruction for operation of equipment.

CAUTION

Ensure minimum weld beads are on gaspath parts. Following welding, fair by blending, if necessary, to avoid flow disturbance. Interference to gaspath flow can cause engine operational difficulty.

f. Observe welding process during machine operation, to detect and correct unsatisfactory welding, should it occur.

g. Remove part from vacuum chamber and inspect weld. Finish weld surface as required per WP/SWP.

h. Clean weld area to remove discoloration, using same methods as in preparation for welding.

i. The high temperature of EB welding, in spite of low total heat, results in a tendency toward increase of hardness, reduction of ductility, and cracking in weld zone following cooling. This tendency is reduced or eliminated by a postwelding stress-relief heat treating cycle, which is required for most materials. The particular cycle is usually specified in WP/SWP.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, PLASMA ARC

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 12	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Welding, Symbols, Preparation, Identification, and Inspection	WP 093 00
Welding, Inert Gas Fusion	SWP 093 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-515
Alcohol, denatured	O-E-760
Alcohol, isopropyl	TT-I-735
Alcohol, methyl	O-M-232
Tetrachloroethylene (perchloroethylene)	O-T-236
Trichloroethane, 1,1,1-, inhibited	MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains general instructions for depot maintenance plasma arc welding. General welding information is given in T.O. 2J-F100-53-1, WP 093 00.

2. GENERAL.

a. Plasma arc is actually a special type of tungsten inert gas (TIG) welding.

b. The difference is that, in plasma arc, the arc column is constricted, making a narrow stream of very high energy gas, called PLASMA. Plasma arc produces a very narrow bead, and has deep penetration.

c. Complete penetration of the weld area somewhat resembles a keyhole, so the operation is referred to as keyholing, or keyhole mode. As the keyhole is made to travel along the joint, penetrating the workpiece, the melted material closes up and solidifies behind the direction of travel.

d. Plasma arc welding has the following advantages over TIG welding:

(1) Better penetration.

(2) Narrower weld bead. This results in a narrower region for minor differences in composition, as when a filler metal slightly different from parent alloy is specified.

(3) Reduced shrinkage.

(4) Elimination of most joint preparation.

(5) Less filler wire required.

(6) Only a single pass needed in machine plasma arc and fewer passes for manual plasma arc, than in TIG welding.

(7) Generally improved weld quality in terms of appearance and possible defects below surface.

e. Plasma arc welding cannot automatically be used in place of TIG welding in all cases.

3. EQUIPMENT FOR PLASMA ARC WELDING.

(See Figure 1.)

a. Manual plasma arc.

(1) Thermal Dynamics WC-100 Control with PWH/M-2A or PWH/M-3A Torch, or equivalent.

(2) Linde PWM-7 Plasma Needle Arc Welder with Linde PT-12 Torch, or equivalent.

b. Machine plasma arc. Typical torch is shown in figure 1.

(1) Linde PWC-2 Plasma Arc Welding Control, or equivalent.

(2) Linde PT-8 Plasma Arc Welding Torch, or equivalent.

(3) Pendant Box.

(4) Junction Box.

(5) Miller Analog 300, or equivalent.

(6) Cold Wire Feeder.

(7) Trailing Gas Shield.

(8) Positioner or Manipulator.

4. TECHNICAL REQUIREMENTS.

a. Minimum thickness for successful keyhole welds in most materials is 0.090 inch.

b. Maximum thickness for successful keyhole welds in most materials is 0.375 inch (nearly 0.500 inch for titanium), for machine plasma arc; and approximately 0.250 inch, for manual plasma arc. Limiting factors are density of the material, and tendency to flow.

c. Some materials as thin as 0.032 inch have been successfully plasma arc welded.

d. Plasma arc welding is especially successful with titanium and nickel alloys.

e. Fixture design depends upon nature of parts, and size of torch. For machine plasma arc, sufficient clearance is required at weld joint for shielding cup and trailing shield, with additional space to prevent double arcing. Double arcing is explained in a later paragraph.

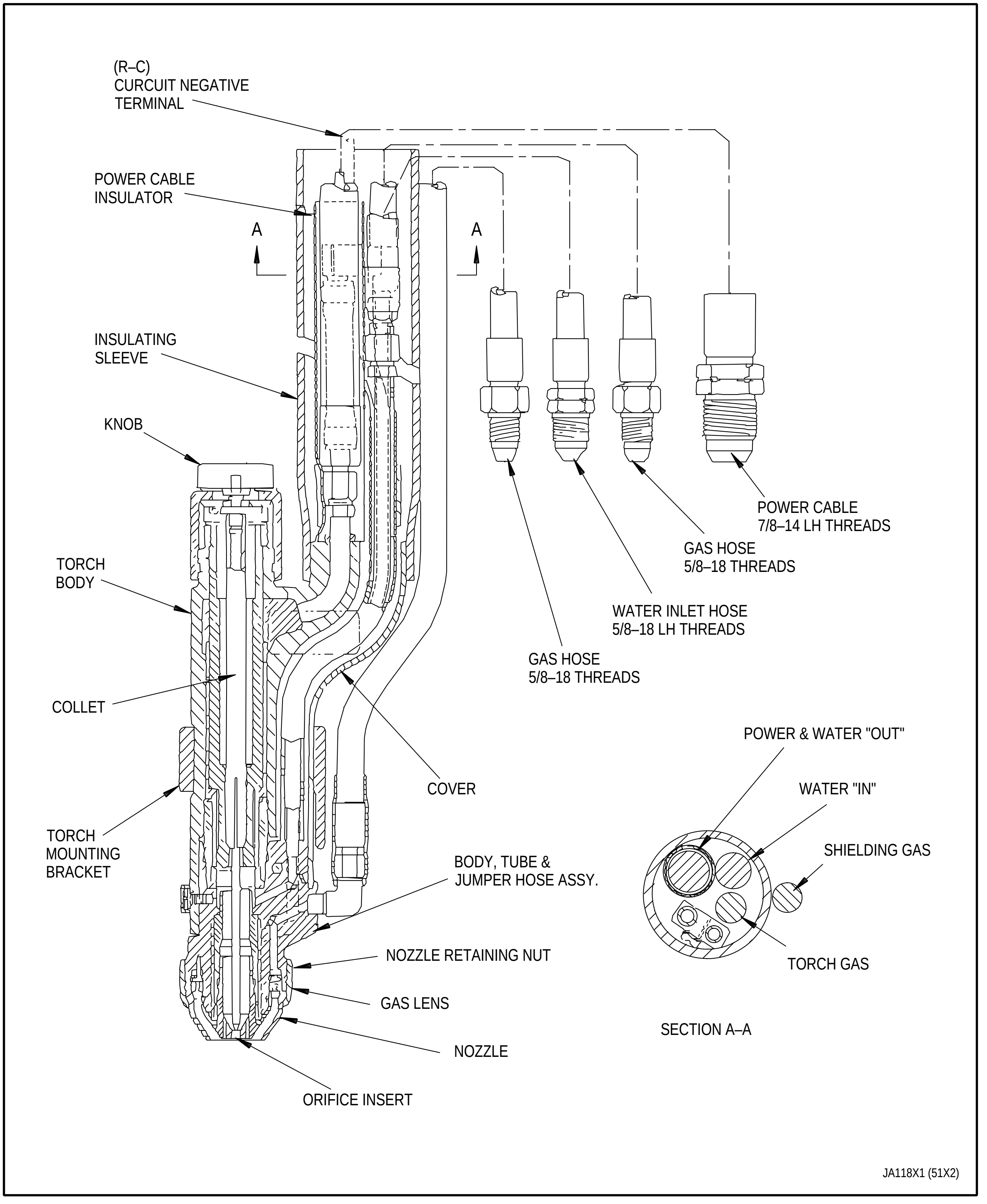


Figure 1. Plasma Arc Machine Torch

5. PREPARATION FOR PLASMA ARC WELDING.

CAUTION

Impurities will weaken welds.

a. Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

CAUTION

Wire brushes used for cleaning corrosion and heat resistant steels and alloys shall have bristles of austenitic corrosion resistant steel. When using wire brushes, ensure that undesirable surface materials are removed, not merely polished over.

b. Wire brushes or silicon carbide abrasives may be used for rough removal of protective coatings, dirt, and surface scale. Oxides shall be removed as far as practicable.

c. For final surface cleaning, use only silicon carbide abrasives, followed by solvent rinse. Authorized solvents are described in following paragraphs.

d. The only solvents authorized for cleaning titanium alloys are O-A-51 acetone and TT-I-735 isopropyl alcohol. If none are available, wipe parts to be welded and the filler metal with a clean, white cloth.

CAUTION

The following solvents shall not be used on titanium alloys.

e. Solvents which may be used to clean weld members and filler materials composed of alloys other than titanium before welding include O-T-236 tetrachloroethylene (perchloroethylene), MIL-T-81533 trichloroethane, O-M-232 methanol, or O-E-760 denatured alcohol.

f. Solvents authorized for titanium (acetone and isopropyl alcohol) may be used on other alloys; however, tetrachloroethylene (perchloroethylene), and trichloroethane are usually preferred for alloys other than titanium because they are nonflammable.

g. Remove all plasma or flame spray, Linde Flame Plate, or any other plate or coating in weld area. These substances would weaken welds. This is especially important when welding near a coated area even when region to be welded is thought to be bare, since overspray may have been permitted.

h. No cleaning deposit or residue shall remain on parts or pieces to be welded.

i. Machining preparation of joint is not generally required for plasma arc welding, up to the maximum thicknesses for manual or machine methods.

6. GENERAL MACHINE PLASMA ARC WELDING PROCEDURES.
(See Figure 2.)

a. Follow same instructions as for TIG welding. Refer to T.O. 2J-F100-53-1, SWP 093 01 and include the following procedures:

b. Before deciding to use plasma arc welding, survey carefully the part to be welded, with special attention to whether assembly has a second surface below or near the weld joint. A plasma jet has enough energy possibly to cut or melt such a second surface, unless adequately protected with a heat shield.

c. Select the following conditions according to thickness and type of alloy of part(s) to be welded:

(1) Gas flow rates.

(2) Power settings.

(3) Welding speed.

(4) Orifice diameter. Too small an orifice causes incomplete penetration. If gas flow and power are increased to overcome this, cutting action results, which reduces life of orifice. Too large an orifice causes a series of oblong holes in the weld. If gas flow is reduced to overcome this, arc goes into TIG mode, and advantages of plasma arc are lost. Each orifice diameter corresponds to an ideal range of thicknesses of parts to be welded. Example: a typical orifice for titanium with a thickness of 0.145 inch, would be 0.094 inch.

d. Plan carefully for inert gas protection of weld puddle and heat affected zone during welding.

(1) The high-velocity jet tends to draw air into the weld, which would oxidize metal. This condition can be overcome by using an adequate shield gas flow.

(2) Also, a trailing gas shield shall be attached to torch assembly. The trailing shield fits snugly over area which has just been welded, and is beginning to cool.

(3) Protect the underside of weld with backup fixturing. Gas groove below joint shall be wide enough adequately to clear maximum width of underbead, and a minimum depth of 0.500 inch. (See figure 2.)

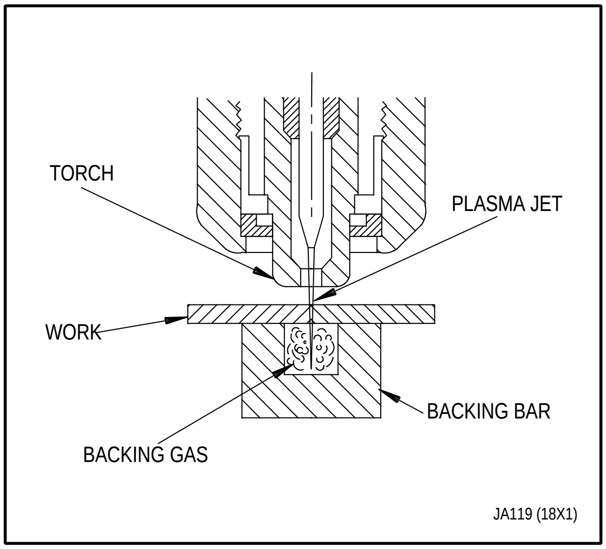


Figure 2. Typical Backup Fixture

e. Establish best possible settings for the following conditions, using a test piece with thickness and composition similar to workpiece to be welded:

(1) Low torch flow.

(2) High (slope) flow.

(3) Shielding gas flow.

(4) Trailer argon flow.

(5) Backup gas flow.

f. After setup with test piece, position actual workpiece without disturbing flow settings.

g. Mismatch requirements for plasma arc are same as those for TIG welding. Maximum mismatch is 25% of thickness of the thinner of pieces to be joined. Generally, satisfactory welds can be made more easily with plasma arc than with TIG welding, where mismatch is involved. See paragraph 2.g. in T.O. 2J-F100-53-1, SWP 093 01.

h. Center the electrode in orifice, using a setup arc, rather than the plasma jet.

i. Fixture workpiece and align weld area visually.

j. Test proper centering of joint by making a tack weld, using low flow mode

NOTE

Wire feed, carriage drive, and related functions are controlled by individual solid-state electronic governors.

k. After startup, welding current will slope up from initial dial setting (for starting slope current), to dial setting for welding current. Length of time for this sequence is set on time dial for starting slope. During slope change, travel or wire feed may be started, or it can be postponed until main welding phase has been reached.

l. When welding arc is established, gas slope system is automatically triggered to commence.

m. When welding of joint terminates, keyhole is smoothly reduced until eliminated, by the gas slope automatic sequence programmer.

n. Backup gas and postflow gas automatically continue to protect weld area until postflow gas timer completes its programmed sequence.

o. Double arcing.

(1) Double arcing is an undesirable condition which must be prevented. This problem is usually peculiar to plasma arc welding, but is possible on a TIG torch with metal gas cup, also.

(2) Definition of double arcing: Instead of striking (normally) directly from electrode to workpiece through orifice, arc may travel from electrode to orifice insert, then to workpiece by way of some other point on front end of torch assembly.

(3) Effect of double arcing is a power loss, resulting in loss of penetration, and thereby a defective weld. Burning of work piece and/or torch components can also be caused by secondary arc.

(4) Common causes for double arcing (which can be easily corrected): too high a current for orifice diameter; too low a gas flow; insufficient torch standoff; improper setback of tungsten electrode; insufficient space between torch and (grounded) fixtures or workpiece.

p. Defects or undercut are unusual, but may be easily repaired by either manual or machine plasma arc; usually repair is done after welding sequence is completed.

7. GENERAL MANUAL PLASMA ARC WELDING PROCEDURES.

a. Follow same instructions as for TIG welding (T.O. 2J-F100-53-1, SWP 093 01), as well as pertinent steps in machine plasma arc welding (paragraph 6, this SWP), and include the following procedures:

(1) Set electrode to previously calibrated distance.

(2) High frequency starting circuit ignites pilot arc, which heats orifice argon to form conductive gas plasma jet.

(3) For titanium, enclose entire fixtured workpiece in a durable clear plastic envelope filled with argon. This manual arrangement replaces the trailing and backup shielding gas in the machine method.

(4) For titanium, torch shielding gas (which flows out around plasma orifice) may be either argon or helium.

(5) For nickel and cobalt alloys, argon with up to 2.5% hydrogen is permissible.

(6) For alloys other than nickel and cobalt, gas shall be argon (purity, minimum 99.995%) or helium (double-charcoal-refined grade). Exception: for titanium, argon shall have minimum purity of 99.998%; maximum free oxygen, 2.5 ppm; and maximum water vapor, 10 ppm, unless other wise permitted in WP/SWP.

(7) Orifice gas may be supplied from a single flowmeter; or from dual flowmeters, one low flow, and the other as high flow for keyhole plasma mode. When two are used, flow is combined downstream into a common hose and duct. Low flow can be used alone for repair, or touchup for improving appearance.

(8) Filler wire may or may not be required.

(9) When manual plasma arc weld is terminated, keyhole is finished by removing torch. This usually leaves a defect hole which is then repaired using melt-in (cosmetic, or low flow) mode.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, MAGNESIUM PARTS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 10	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Chromate Conversion, Chemical, for Magnesium (SPOP 41)	SWP 092 15
Welding, Inert Gas Fusion	SWP 093 01
Painting, Aluminized Epoxy Enamel (PWA 568, PWA 569) (SPOP 148)	SWP 097 04

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, denatured	O-E-760
Ceramic fiber, bulk	Fiberfrax
Cleaner for dye penetrant	Spotcheck SKC-NF or Dy-Chek Remover No. 3 or Remover K-410E
Dye penetrant, visible contrast	Spotcheck SKL-HF or Dy-Chek Penetrant or Penetrant P-300

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance welding of magnesium parts.

2. GENERAL.

a. Magnesium engine parts requiring weld repair shall be welded by inert gas fusion welding. General information is contained in T.O. 2J-F100-53-1, SWP 093 01.

b. For cast magnesium parts of AMS 4434 parent metal, the direct current (DC) reverse polarity method is recommended. The lower heat generated by this technique is helpful for welding thick, highly restrained regions, as there is less tendency toward developing internal stresses and/or cracks. Once the weld has advanced away from a massive region, current may be changed to alternating current (AC). With this option, it may be possible to add filler metal faster.

c. Preheating is required only for certain configurations and alloys of magnesium. When ovens are used, they shall be large enough for entire parts. Occasionally, parts with thick or highly restrained regions are preheated by means of the vapor degreaser.

d. When welding magnesium, holding torch at right angles to work piece, and maintaining a close, consistent arc results in the following benefits:

(1) Causes least porosity.

(2) Produces least total heat in part.

3. EQUIPMENT.

a. Welding machine such as P & H AC/DC arc welder, 300 ampere single phase, 12 to 70 ampere output, or equivalent.

b. Linde HW-20 torch with Linde H-5V45 collet body gas lens, No. 7 cup, or equivalent.

c. Electrode, pure tungsten, 0.125 inch diameter.

d. Filler wire, AMS 4395 (AZ92), 0.093 inch diameter.

e. Inert gases: argon and helium, separately or blended.

4. REPAIR PROCEDURE, AC MODE, WHERE DEPTH OF CRACK DOES NOT EXTEND THROUGH PARENT MATERIAL.

a. Routing.

(1) Using rotary file, rout out entire crack by Vee-grooving.

(2) Maintain rout width 4/16 to 5/16 inch, and not deeper than 75% thickness of parent metal.

(3) Inspect with visible contrast dye penetrant to ensure entire crack length has been routed. Remove all traces of penetrant with penetrant cleaner.

b. Cleaning.

(1) Using rotary file, clean surface of part to at least 3/4 inch surrounding intended weld path.

(2) Remove all surface coating to expose bright, shiny parent metal.

(3) Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(4) Wipe area to be welded with clean cloth, wet with O-A-51 acetone, O-E-760 denatured alcohol, or other clean solvent.

(5) Polish filler wire with silicon carbide cloth or aluminum wool; clip off and discard short length from starting end; and degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(6) Wipe filler wire with clean cloth, wet with O-A-51 acetone, O-E-760 denatured alcohol, or other clean solvent.

(7) Ensure that part(s) to be welded, and filler wire are thoroughly dry before welding.

c. Preheating. Use temperature-indicating crayon for temperature control.

(1) AMS 4434 material. Preheat to 350°F (177°C) maximum.

(2) AMS 4418 material. Preheat to 400°F (204°C) maximum.

(3) AMS 4442 material. Preheating is optional. When used, preheat to 400°F (204°C) practical maximum, or to 500°F (260°C) absolute maximum. Time at 500°F (260°C) shall not exceed 90 minutes.

(4) Remove part(s) from oven, and immediately cover with ceramic fiber blanket, leaving exposed only area to be welded.

(5) Maintain part at preheat temperature throughout welding, insofar as practicable.

d. Welding. Fill routed area with multiple, successive passes in opposite directions to minimize stress. After each pass, remove smoke deposits with stainless steel brush.

e. Inspection.

(1) Clean welded area, and inspect with visible contrast dye penetrant.

(2) X-ray inspect if internal cracking or excessive porosity would be detrimental to structure or to final machined surface. Repair if necessary.

(3) Any cracks detected shall be rewelded per this SWP.

f. Rewelding. If repeated attempts to repair cracks are unsuccessful, and only result in further cracking at or near weld bead, repair as follows:

(1) Rout out entire defective area to make a slot or hole through part.

(2) Ensure that all cracked material is removed.

(3) Weld opening, starting at wall of slot or hole.

(4) Before starting final pass only, remove enough weld filler material to expose bright, shiny surface.

g. Stress-relief. There is no time limit between welding and stress-relief.

CAUTION

Slow cool following stress-relief.

(1) AMS 4442 material. Stress-relieve at 410° to 430°F (210° to 221°C) for 5 hours.

(2) AMS 4434 material, and most other magnesium alloys. Stress-relieve at 350°F (177°C) for 2 hours in air.

(3) AMS 4418 material. Stress-relieve at 425°F (219°C) for 2 hours.

(4) AMS 4442 material. Stress-relief is optional.

(5) Remove part(s) from oven. Wrap entire part in ceramic fiber blanket, or place part in closed box of bulk ceramic fiber. Allow to cool slowly to room temperature.

h. Post-treatment.

(1) Clean welded area.

(2) Inspect all welds.

(3) Machine to original configuration.

(4) Apply chromate conversion coat to bare metal surfaces per T.O. 2J-F100-53-1, SWP 092 15, as required.

(5) Apply yellow epoxy primer and aluminized epoxy enamel per T.O. 2J-F100-53-1, SWP 097 04, as required, or yellow epoxy primer only, if so specified per WP/SWP.

5. REPAIR PROCEDURE, AC MODE, WHERE CRACKS EXTEND THROUGH PARENT METAL, ACCESSIBLE ON BOTH SIDES. (See Figure 1.)

a. Cleaning.

(1) Using rotary file, clean part surface to at least one inch surrounding intended weld path, if possible.

(2) Remove all surface coating to expose bright, shiny parent metal.

(3) Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(4) Wipe area to be welded with clean cloth, wet with O-A-51 acetone, O-E-760 denatured alcohol, or other clean solvent.

(5) Polish filler wire with silicon carbide cloth or aluminum wool; clip off and discard short length from starting end; and degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(6) Wipe filler wire with clean cloth, wet with O-A-51 acetone, O-E-760 denatured alcohol, or other clean solvent.

b. Preheating. Use temperature-indicating crayon for temperature control.

(1) AMS 4434 material. Preheat to 350°F (177°C) maximum.

(2) AMS 4418 material. Preheat to 400°F (204°C) maximum.

(3) AMS 4442 material. Preheating is optional. When used, preheat to 400°F (204°C) practical maximum, or to 500°F (260°C) absolute maximum. Time at 500°F (260°C) shall not exceed 90 minutes.

(4) Remove part(s) from oven, and immediately cover with ceramic fiber blanket, leaving exposed only area to be welded.

(5) Maintain part at preheat temperature throughout welding, insofar as practicable.

c. Welding thin shelf-like parts.

(1) Apply overlapping bead welds to all surfaces adjacent to crack for minimum distance of one inch on either side. (See figure 1.) This is to reinforce part prior to routing and welding.

(2) Rout out cracked area to depth of 50% of parent metal thickness by Vee-grooving, using rotary file.

(3) Fill routed area with multiple, successive passes in opposite directions to minimize stress. After each pass, remove smoke deposits with stainless steel brush.

(4) Upon completing weld, rout out opposite side of crack in same manner, to depth required for complete removal of defects.

(5) Place part back in oven, and restore specified heat treat temperature.

(6) Remove part from oven, and immediately cover with ceramic fiber blanket, leaving exposed only area to be welded.

(7) Fill routed area (of opposite side of crack) with multiple successive passes in opposite directions to minimize stress. After each pass, remove smoke deposits with stainless steel brush.

d. Welding parts of normal thickness (not thin shelf-like structures). Follow same welding procedure as in paragraph 5.c., but omit step 5.c.(1).

e. Inspect, repair if necessary, stress-relieve, and apply post-treatment steps as in paragraphs 4.e. through 4.h., this SWP.

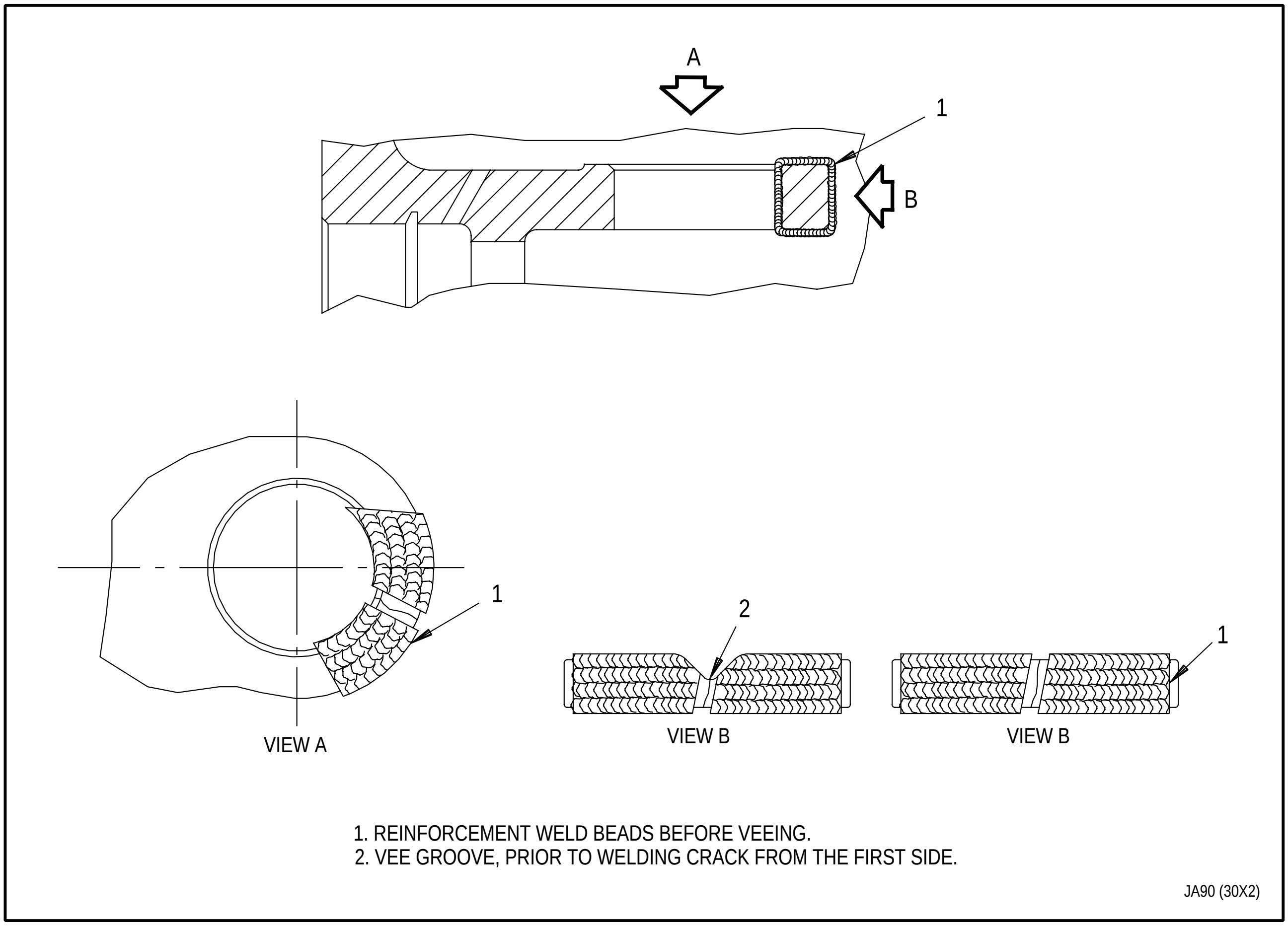


Figure 1. Overlapping Bead Welds

6. REPAIR PROCEDURE, DC REVERSE POLARITY MODE.

a. Follow same cleaning, routing, and preheating procedures as for AC mode.

b. Welding.

(1) Weld defective area on part using DC reverse polarity, 60 amperes maximum, low range.

(2) Use torch gas mixture of argon (30 cubic feet per hour (CFH) at 30 psig) with helium (45 CFH at 30 psig).

(3) Holes or cracks extending through parent metal shall be backed with inert gas. Argon or helium may be used for backing.

(4) Fill routed area as required. A typical crack rout 1/4 inch wide by 3/16 to 4/16 inch deep can be filled with one pass. Passes up to 3 inches long can be completed without stopping.

(5) For weld buildup, or when multiple passes are required, make successive passes in opposite directions to minimize stress. After each pass, remove smoke deposits with stainless steel brush.

(6) Rout out cracks extending through wall sections, to 75% of parent metal thickness, then weld. Invert part, and rout down to filler metal of first pass on opposite side, to completely remove all weld expulsion and any remainder of crack, to expose bright, shiny metal of filler. Complete welding.

(7) If opposite side of weld is inaccessible, use multiple pass technique, making successive passes in opposite directions. First pass shall completely penetrate cracked area at bottom of rout.

c. Follow same inspection, repair, stress-relief, and post-treatment steps as for AC mode.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, TITANIUM PARTS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 6	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information -------------	T.O. 2J-F100-53-1
Welding, Inert Gas Fusion ---------------------	SWP 093 01
Heat Treatment, General ----------------------	WP 095 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, isopropyl	TT-I-735

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains general instructions for depot maintenance welding of titanium parts.

2. GENERAL.

a. Welding of titanium is similar to welding of other high strength, corrosion resistant alloys, except that titanium is unusually sensitive to contamination. For this reason, special consideration is required for the following:

(1) Cleaning and preparation for welding.

(2) Purity of welding gas and cover gas.

(3) Stress-relief.

b. For general inert gas fusion welding procedures, see T.O. 2J-F100-53-1, SWP 093 01.

3. PRECLEANING.

CAUTION

Impurities will weaken welds.

a. Quality of tungsten inert gas (TIG) welding of titanium depends strongly on absence of all contaminants.

b. Prevention of air contamination is critically important. Titanium welding is adversely affected by both oxygen and nitrogen in air atmosphere. Above 1200°F (649°C), titanium combines rapidly with traces of impurities, and the result is a permanent reduction of:

(1) Fatigue life.

(2) Tensile strength.

(3) Ductility.

c. Since the temperature of molten titanium is approximately 2900°F (1593°C), both the weld bead and the surrounding parent metal area are especially susceptible to impurities in welding gas or on surfaces of part(s).

d. Front and back surfaces of parts to be welded shall be thoroughly cleaned of all traces of oxides, dirt, oil, or other impurities, insofar as possible. Even a fingerprint on the cleaned metal surface can contaminate the weld sufficiently to cause cracking.

e. In some instances where the back of the area to be welded is normally inaccessible for cleaning, consideration may be given to routing out the defective area to be welded to form the smallest possible hole through which the underside of the surrounding area may be mechanically cleaned. The weld repair then becomes the welding in of a small patch to fill this access hole.

f. Following cleaning operation, surfaces to be welded shall be completely dry, and free of any cleaning agent residue. Vaporizing such residues could contaminate weld atmosphere.

g. If electron beam welding is to be used, any final water rinse prior to welding shall contain less than 50 ppm total dissolved solids, and less than 10 ppm chlorides.

h. Case assembly inner compartments may be dried by baking for one hour in air at 285° to 315°F (141° to 157°C).

i. Silicon carbide abrasives only shall be used for final surface cleaning and oxide removal, followed by a solvent rinse.

j. The only solvents authorized for rinsing titanium are O-A-51 acetone and TT-I-735 isopropyl alcohol.

4. PROTECTIVE INERT GAS.

a. Inert gas used shall be argon and/or helium of not less than 99.998% purity, containing not more than 2.5 ppm free oxygen, and not more than 10 ppm water (vapor), unless otherwise specified per WP/SWP.

b. Inert gas shall effectively cover both front and back of weld area.

c. Titanium welding is sometimes done in a clear, durable plastic envelope; however, a pressurized enclosure filled with inert gas is preferred whenever possible.

d. The inside of hollow parts, such as inlet guide vane assemblies, shall be purged with inert gas.

e. For TIG welding, gas backing is necessary at underside of weld, whenever exposure to atmosphere would otherwise occur. Backing protection may be provided by fabricating small, box-like fixtures having edges shaped to fit contour of part to be welded and using a Victor 50-20 Argon Connector, or equivalent, to secure line. Seal fixture to part to conserve as much inert gas as possible.

f. If an enclosure is not available for certain hollow parts, such as inlet guide vane assemblies or diffuser cases, holes and openings may be temporarily plugged, and entire inner area purged with inert gas, so as to flow out of, or past area to be welded. It may be necessary to feed gas in at one side of area to be repaired, and open a small vent at other side, to accomplish purge.

g. Ample time shall be allowed when purging with inert gas, for all the air inside each part to be replaced by the inert gas.

h. When an enclosure is used, air inside may be evacuated with vacuum pump prior to first filling with inert gas. First filling shall then be pumped out and replaced by second filling, and so forth, repeating the process until required purity is obtained.

5. WELDING.

a. Before actual weld, test purity of inert atmosphere by means of spot welds on test piece of titanium sheet metal placed inside enclosure. Clamp, support, or bend test piece so that edges are freely exposed to atmosphere being checked, and locate close to area on part to be welded.

b. As trace content of oxygen in atmosphere decreases, tack welds made on titanium will show improvement through a range of color changes. Color indication of quality going from bad to good is as follows:

NOTE

- Colors apply only to actual center of tack weld. Disregard customary narrow blue band, farther out in the heat affected zone.
- Also disregard various shades of blue normally produced by stress-relief after welding. This coloring is not related to prior weld contamination.

(1) Blue.

(2) Light blue.

(3) Yellowish blue.

(4) Yellow.

(5) Straw.

(6) Light straw.

(7) Silver.

c. Silver colored tack welds are preferred, and shall be obtained on test piece before proceeding with repair welding.

d. Acceptable color for welds prior to stress-relief is limited to SILVER or LIGHT STRAW.

6. POST-WELDING TREATMENT.

a. When titanium is welded outside an enclosure, with local coverage by inert gas, ensure inert gas shielding of both sides of weld area during cooling to at least 1100°F (593°C). Impurities and oxygen will not be absorbed at this temperature.

b. When an enclosure is not used, hold torch in position after arc has stopped, with gas flowing for 5 to 10 seconds, to provide protection for weld area while cooling.

c. Stress-relieve welded part per WP/SWP. Additional information on heat treatment of titanium parts is given in T.O. 2J-F100-53-1, WP 095 00.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - WELDING, RESISTANCE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 9	0	10 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning, Carbon Solvent and Paint Stripper, Two Step (SPOP 7)	SWP 031 04
Welding, Symbols, Preparation, Identification, and Inspection	WP 093 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance resistance welding. For general welding information, see T.O. 2J-F100-53-1, WP 093 00.

2. GENERAL. (See Table 1.)

a. Resistance welding (spot, seam, or stitch) is a metal joining method depending on two factors:

(1) Holding parts to be joined together under pressure, without filler material.

(2) Using the electrical resistance at the intended joint as the means of heating.

b. Spot welding uses pointed or domed electrodes, which are brought against or removed from workpiece(s) at predetermined times and rates.

c. Tack welding is the use of holding-type (temporary) spot welds. Tack welds are not structural welds, and when used, shall be located finally within an actual structural weld, without being detrimental to that weld.

d. Stitch welding consists of overlapping spots, and uses spot-type electrodes to produce a continuous seam.

e. Seam welding is a process using roller-type electrodes.

f. Seam welding may be substitued for stitch welding, but stitch welding shall not be substituted for seam welding, unless specifically permitted per work packages/subordinate work packages.

g. The American Welding Society (AWS) process codes for resistance welding methods are listed in table 1.

h. The same terminology; spot, stitch, or seam, is also applied to certain arc-type fusion welds. Therefore, these terms should include the words arc or resistance, to avoid confusion. Example: arc-spot versus resistance spot.

Table 1. Resistance Weld Process Codes

Weld Process	AWS Letter Designation
Resistance Weld	RW
Resistance Spot Weld	RSW
Resistance Seam Weld	RSEW

3. SYMBOLS.

a. Standards symbols are explained in T.O. 2J-F100-53-1, WP 093 00. Information relating to resistance welds is included in the welding symbol or provided in notes per work packages/ subordinate work packages. This information usually includes the following:

(1) Fused zone size.

(2) Strength.

(3) Spacing.

(4) Extent.

(5) Other data for fabrication or repair.

4. ELECTRODES.

a. Welding electrodes shall have physical and electrical characteristics required for producing acceptable welds, according to composition and thicknesses of weld members.

b. Machine dressing is preferable for electrodes. Redressing is required whenever tip or edge contour changes sufficiently so that penetration requirements cannot be met. (See paragraphs 6.g. and 6.h.)

5. WELDING SCHEDULES.

a. In order to comply with requirements for fused zone size, strength, spacing, and extent, at least five consecutive test specimens shall be welded.

b. All details of machine set-up shall comprise a welding schedule for conditions resulting in satisfactory welds.

c. Test specimens shall correspond to parts to be welded in the following manner:

(1) Same or equivalent material composition.

(2) Approximately same thickness.

(3) Having same cleaning preparation.

(4) When practical, having similar shape of section of part represented.

(5) Having overlap not greater than overlap of part(s) to be repaired.

6. TECHNICAL REQUIREMENTS.
(See Figure 1.)

a. Strength and size.

(1) Strength of individual spot welds shall be not less than minimum specified in work packages/subordinate work packages. Strength testing is not routinely required.

(2) Fused zone diameters of individual spot and projection welds, as measured at each interface of joint, shall be not smaller than specified in work packages/subordinate work packages.

(3) When fused zone width of seam and stitch welds is specified per work packages/subordinate work packages, seam width shall be not less than 90% of that specified, and stitch width shall be not less than 70% of than specified.

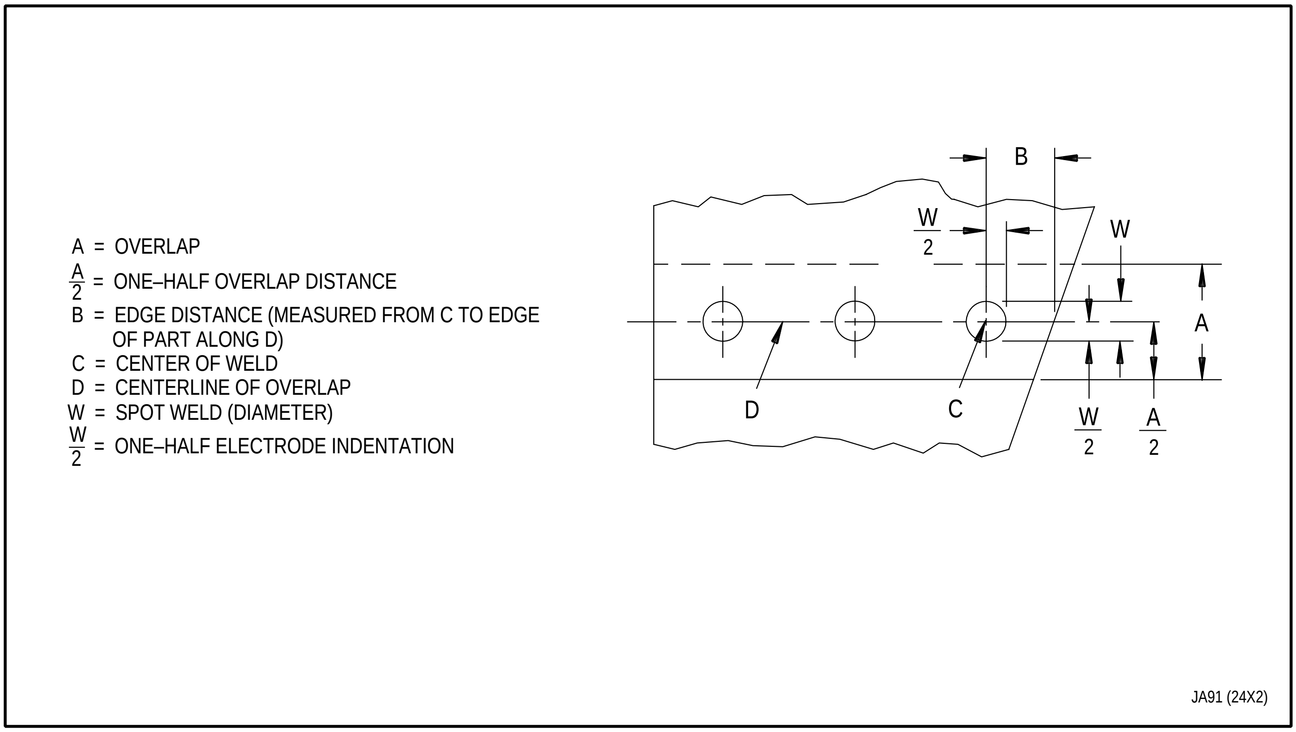


Figure 1. Positioning of Spot, Stitch, and Seam Welds

b. Shear strength consistency. Shear strength tests are not routinely required; however, in order to demonstrate welding machine’s ability to produce welds of consistent strength, the following guidelines are given:

(1) In a consecutive series of aluminum or magnesium test specimens, at least 90% of specimens shall have shear strength within ±12.5% of average value, and within ±25% in the remaining specimens.

(2) In a consecutive series of test specimens other than aluminum or magnesium, annealed and stress-relieved, at least 86% of specimens shall have shear strength within ±10% of average value, and within ±20% in the remaining specimens.

c. Positioning. Unless otherwise specified per work packages/ subordinate work packages, resistance welds shall be positioned as shown in figure 1.

(1) Welds shall be centered on overlap A, along centerline D. Distance from centerline of overlap to edge of piece, if specified in work packages/subordinate work packages, shall be within; 0.060 inch of that specified.

(2) For spot welds, edge distance B shall be not less than one-half of overlap. Edge distance B, if specified in work packages/ subordinate work packages, shall be within 0.060 inch of that specified.

(3) Edge distance B requirement shall be waived for stitch or sea welds along centerline D of overlap, provided there is no thinning, excessive expulsion, cracking, deformation, or bulging at edge of piece.

(4) Center C of weld shall be located at a distance one-half of electrode indentation of weld W, measured in from edge of fused zone.

(5) Edge distance B shall be measured from center C of weld to edge of part along centerline D.

d. Length (extent) of seam and stitch welds. Length of seam and stitch welds shall be not less than that specified in work packages/subordinate work packages.

e. Indentation in foil-backed porous sheet abradable materials. Unless otherwise permitted per work packages/ subordinate work packages, indentation of assembly, not including the porous sheet, shall not exceed 10%.

f. Indentation in parts other than foil-backed porous sheet abradable materials.

(1) Unless otherwise permitted per work packages/ subordinate work packages, indentation on formed or stamped parts (not deep-drawn) shall not exceed 10% of sum of average thicknesses of outer parts.

(2) For deep-drawn parts with thinned areas to be welded, indentation shall not exceed 10% of actual thickness at welded joint or 82% of average thickness of original material, whichever is greater.

g. Penetration in foil-backed porous sheet abradable materials. Unless otherwise permitted per work packages/ subordinate work packages, weld penetration through the porous sheet and backing foil shall be 100% and 20 to 50% into the mating part.

h. Penetration in parts other than foil-backed porous sheet abradable materials.

(1) Unless otherwise specified per work packages/ subordinate work packages, weld penetration into each outer piece shall be not less than 20% of indented thickness of thinner piece, and not more than 80% of indented thickness of respective pieces (90% in case of titanium).

(2) Stitch (overlapping spot) welds shall have spots spaced to satisfy preceding requirement at any point along length of weld, except for a distance of one-half spot diameter at each end of any stitch weld not forming a closed loop.

i. Tack welds.

(1) Tack welds (for holding purpose) shall not be injurious to parent metal or detrimental to final quality weld.

(2) Unless otherwise permitted per work packages/ subordinate work packages, tack welds shall be completed contained within final quality weld.

j. Sheet separation. Unless otherwise specified per work packages/subordinate work packages, sheet separation between adjacent welds shall not exceed 10% of thickness of thinnest sheet being joined, or 0.015 inch, whichever is less.

k. Tolerances. Unless otherwise specified per work packages/ subordinate work packages, the following tolerances are permitted.

(1) Spacing between individual spot welds, and between rows of spot welds shall be within 0.060 inch of spacing specified by work packages/ subordinate work packages.

(2) Spacing between seam welds shall be within 0.060 inch of spacing specified by work packages/subordinate work packages.

(3) In stitch welding, number of spots per inch, as measured over any given inch of weld, shall not be fewer than number on a test specimen, prepared with minimum number of spots to give a stitch weld, meeting all other requirements.

7. GENERAL RESISTANCE WELDING PROCEDURE.

CAUTION

Impurities will weaken welds.

a. Cleaning preparation.

(1) Parts to be welded shall be free from scale, oxides, dirt, dust, plasma or flame spray coatings, Linde Flame Plate, electroplate, paint, or any substance detrimental to welding process.

CAUTION

Wire brushes used for cleaning corrosion and heat resistant steels and alloys shall have bristles of austenitic corrosion resistant steel. When using wire brushes, ensure that undesirable surface materials are removed, not merely polished over.

(2) Wire brushes or silicon carbide abrasives may be used for rough removal of protective coatings, dirt, or surface scale. Silicon carbide abrasive only shall be used for final surface cleaning and oxide removal, followed by solvent rinse.

(3) Final cleaning of aluminum parts for removal of loosened oxide shall be with T.O. 2J-F100-53-1, SWP 031 01 or SWP 031 04, followed as soon as practicable by fixturing and resistance welding.

(4) No undesirable deposit or residue from cleaning operations shall remain on surfaces to be welded.

(5) Approved dye markings are permitted for spotting weld locations, except on aluminum or titanium parts.

(a) Assembling for welding.

- Parts to be welded shall be assembled using necessary jigs, fixtures, clamps, etc, so that after weldings, parts will be in proper alignment.
- Unless otherwise specified in WPs/ SWPs, tack welds used for holding purposes shall be located on centerline of structural (quality) welds to be made.

(b) Welding.

- Set up welding machine per welding schedule. If no schedule exists, determine one per paragraph 5.
- Weld representative test specimens. Ensure that all technical requirements (paragraph 6) are satisfied, using destructive or mechanical methods on test specimens, as necessary.
- Weld parts. Normally, electrode tip may be cleaned periodically by applying slight, rotating pressure to tip surface, against a soft lead or wooden bar, covered with No. 240 aluminum oxide cloth. Remove any residual foreign material from electrode tip with a clean cloth.

CAUTION

Under no condition shall weld be cleaned or dressed in such a way as to cause thinning of parent material.

(c) Post weld cleaning. Remove excessive weld flash and pickup material by filing, light grinding, or wire brushing.

(d) Inspection. Visually inspect welds for appearance, flash removal, conformance to overlap requirements, indentation, and sheet separation.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BRAZING, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 16

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Plating, Nickel, on Stainless Steel, Nickel, or Cobalt (SPOP 26)	SWP 092 10

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Ceramic fiber, bulk	Fiberfrax
Nitric acid	O-N-350
Oil, mineral seal	Mentor No. 28 or Shell Pella 911 or Texaco 300 oil
Tetrachloroethylene (Perchlorethylene)	O-T-236
Corrosion inhibitor water conditioner	Reilly-Whiteman X74-26A

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance brazing.

2. GENERAL.
(See Table 1.)

a. Brazing is defined as the joining of metals by means of heat and a nonferrous filler material whose melting point is above 800°F (427°C), but below that of the metals being joined.

b. Brazing is used with closely fitted surfaces, between which the filler material is drawn by capillary action.

c. Types of brazing used in jet engine repair include various alloys of silver, nickel, and gold.

(1) High temperature silver braze.

(2) Low temperature silver braze.

(3) Gold-nickel alloy braze.

(4) Nickel alloy braze.

(5) Nickel-phosphorus brazing of alloy fiber metal.

d. Brazing process requirements include specifications for brazing method, brazing material, brazing flux, temperature, atmosphere, and preparation by nickel plating. Table 1 outlines these requirements.

Table 1. Brazing Process Requirements

Process Specification	Brazing Method (1)	Brazing Material	Brazing Flux	Atmosphere	Prebraze Nickel Plate	Temperature
Silver, High Temperature, AMS 2664 (2)	I, F (3), V	AMS 4765 (PWA 707)	None	Protective	See Paragraph 9.	1950°F (1066°C) maximum
	I, T	AMS 4772	AMS 3411 or PWA 809	Air		
Silver, High Temperature, AMS 2666	F (3) (4)	AMS 4772	None	Protective	-	1850°F (1010°C) maximum
	I, T	AMS 4772	AMS 3411	Air		
Silver, High Temperature, PWA 85	I, F (4), V	PWA 706 plus acrylic binder or PWA 715 plus acrylic binder or PS 142	None	Protective (5)	See Paragraph 9.	1825°F (996°C)
Silver, Low Temperature AMS 2665	I, T	AMS 4770	AMS 3410	Air	-	1350°F (732°C) maximum
Gold-Nickel, PWA 19	I, F, V (Nonharden-able alloys)	AMS 4787 (PWA 698) or PWA 718 or PS 109	(PWA 809 for Induc-tion only)	Protective (5)	See Paragraph 9.	1800° to 1950°F (982°C to 1066°C)
	F (4) (Hardenable alloys)	AMS 4787 (PWA 698) or PWA 718 or PS 109	None	Protective	See Paragraph 9.	1825°F (996°C)

Table 1. Brazing Process Requirements (continued)

Process Specification	Brazing Method (1)	Brazing Material	Brazing Flux	Atmosphere	Prebraze Nickel Plate	Temperature
Nickel, AMS 2675	F, V	PWA 996 or PWA 1181 or AMS 4777 or AMS 4778 or AMS 4779 or AMS 4782 or AMS 4783	None	Protective (5)	See Paragraph 9.	As specified per WPs/SWPs
Nickel - Phosphorus, PWA 34	F, V	Electro-less Nickel Plate per SWP 092 28	None	Protective (5)	-	As specified per WPs/SWPs

NOTES

(1) I = Induction; F = Furnace; T = Torch; V = Vacuum furnace.
(2) For nonhardenable alloys or unhardened steels and alloys.
(3) Tube assemblies to be brazed after installing silver plated nuts shall not be furnace brazed.
(4) Use only as part of a complete heat treatment and when hardness of parts will not be reduced below acceptable limits. See paragraph 4.
(5) Vacuum furnace method may replace vacuum with partial pressure inert gas to reduce vaporization of braze material. See paragraph 3.

3. PROTECTIVE ATMOSPHERES. (See Table 2.)

a. Brazing atmosphere is usually hydrogen gas, since this not only eliminates air oxidation, but also because hydrogen has the tendency to combine with and remove impurities such as oxides.

b. The hydrogen for brazing shall be at least 99.94% pure, and have a maximum dew point of −25°F (−32°C).

c. The dew point is the temperature at which moisture can condense, but in gas specifications, it is an indication of the water vapor content.

d. Testing of protective atmosphere (as for dew point) is done on gas samples taken where being exhausted from furnace or retort work zone.

e. If parts to be brazed are absolutely free of oxides and scale, hydrogen may be replaced by argon, vacuum, or a blend of argon and hydrogen per table 2.

f. An atmosphere other than hydrogen or any of those listed in table 2 may be substituted, if so specified in WP/SWP in special instructions for a particular part.

Table 2. Alternate Protective Atmospheres

Brazing Atmosphere	Dew Point, Maximum	Purity, Minimum
Argon	−35°F (−37°C)	99.99%
Argon/Hydrogen (in any proportion	−35°F (−37°C)	Argon: 99.99% Hydrogen: 99.94%
Vacuum	-	20 Microns mercury or lower

g. When vacuum is used as the brazing environment, argon may be introduced after braze operation, to aid in cooling of parts brazed to the following:

(1) PWA 85 high temperature silver braze.

(2) PWA 19 gold-nickel braze.

(3) AMS 2675 nickel braze.

(4) PWA 34 nickel-phosphorus braze.

h. For vacuum brazing to PWA 85 high temperature silver braze, using PWA 706 brazing material, or other braze process using alloy susceptible to vaporizing under high vacuum, argon may be introduced to maintain a partial pressure during heating, brazing, and remainder of cycle.

4. HEAT TREATMENT.

CAUTION

Hardenable alloys would be excessively hardened, if given only a furnace braze cycle. Parts made of these materials shall receive a complete heat treatment cycle, including tempering, precipitation heat treatment, etc. after the brazing cycle, in order to be transformed to the desired physical condition.

a. Furnace brazing shall not be used for parts which have previously been hardened, unless specified in WP/SWP, including rehardening information in the repair procedure.

b. If special hardness or heat treatment are necessary, such requirements shall be outlined in pertinent WP/SWP.

c. If silver brazed assemblies are stress-relieved, heat treatment shall be followed by inspection of brazed joints, and braze repaired if necessary.

d. Most materials and parts require postbraze heat treating, including internal tubing as in bearing compartments, cases and case struts, etc.

e. External tube assemblies may usually be silver brazed without postbraze heat treatment if permitted by WP/SWP, and when the following is determined:

(1) That the parts are composed of nonmagnetic, nonhardenable material, either austenitic stainless steel or nickel base alloy. (Check with a magnet.)

(2) Previous braze material is silver. A test to distinguish silver braze from gold-nickel is outlined in a later paragraph.

f. Tube assemblies composed of Type 410 steel.

(1) When no hardness requirement, stress-relieve at 1180° to 220°F (638° to 660°C) for 15 to 30 minutes.

(2) When hardness requirement is to a hardness of Rockwell C25 to 33, or Rockwell C30 to 38, stress-relieve at 1000° to 1030°F (538° to 544°C) for 2 hours.

(3) If, during local heat treatment, an aluminum nut cannot be moved far enough away from heated zone, wrap nut with wet bulk ceramic fiber to keep it cool.

(4) Local heat treatment is recommended only if furnace heat treatment would be detrimental to some component of the assembly.

5. REPAIR OF TUBE ASSEMBLIES ORIGINALLY BRAZED WITH EITHER LOW OR HIGH TEMPERATURE SILVER BRAZE.

a. Unless otherwise specified per WP/SWP, repair brazing shall be done with high temperature silver braze only.

6. REPAIR OF FUEL MANIFOLDS.

a. Fuel manifolds are nearly always gold-nickel brazed, and shall not be repair brazed by any process unless specifically authorized per WP/SWP.

7. REPAIR OF COPPER BRAZED JOINTS.

a. Repair of copper brazed joints shall not be attempted unless specifically authorized per WP/SWP.

8. TEST TO TELL SILVER BRAZE FROM GOLD-NICKEL BRAZE.

a. A chemical test is required to distinguish silver and gold-nickel brazes, because of their similar colors. Use the following procedure:

(1) On vane and shroud assemblies, make test on ID of inner shroud.

(2) Degrease brazed area by wiping with a clean cloth moistened with tetrachloroethylene (perchlorethylene) or comparable solvent.

(3) Lightly abrade brazed area to be checked, using a silicon carbide cloth, to remove plated or protective coating.

(4) Dilute a small quantity of nitric acid with an equal amount of water.

(5) Apply one drop of the diluted nitric acid to the abraded brazed area. Blot off with absorbent tissue.

(6) Apply a second drop of the diluted nitric acid to the same spot, observe for the following possible conditions:

(a) No reaction in minimum of 5 minutes. Braze is gold-nickel.

(b) Strong reaction (gassing in 30 to 60 seconds) or mild reaction (greenish color in 1 to 2 minutes). Braze is silver or copper.

(7) Remove liquid and residue with absorbent tissue.

(8) Rinse with clean water and dry.

9. PREBRAZE NICKEL PLATING REQUIREMENT.
(See Table 3.)

a. Unless otherwise specified per WP/SWP, parts to be silver brazed per AMS 2664 or PWA 85, or gold-nickel brazed per PWA 19, shall be prepared by nickel plating under the following conditions:

(1) Brazing to be by vacuum furnace or by induction or furnace methods in a protective atmosphere.

(2) Nickel plating to be per T.O. 2J-F100-53-1, SWP 092 10 to the thicknesses specified for various alloys, listed in table 3.

(3) When using PWA 996 nickel brazing alloy, prebraze nickel plating preparation is required regardless of composition of parts to be joined, in order to have satisfactory braze flow.

Table 3. Prebraze Nickel Plate Thicknesses

Alloy to be Brazed (Note 1)	Plate Thickness, Inch
AISI 321	0.0001 to 0.0003
17-7PH AM-363 A-286 PH 15-7Mo Custom 455	0.0004 to 0.0006 (Note 2)
Inconel 706 Inconel 718 Inconel X-750 Incoloy 901	0.0004 to 0.0006 (Note 2)
Waspaloy’ Astroloy’ Udimet 500 Udimet 700 IN-100 Inconel 713 Mar-M200 B-1900 NX-188 Inconel 738 Inconel 792	0.0008 to 0.0012 (Note 2)
Inconel 600 Inconel 625 Hastelloy N	0.0001 to 0.0003

Note 1. For alloys other than those listed, 0.0001 to 0.0003 inch may be used.
Note 2. For brazing by vacuum furnace, 0.0001 to 0.0003 inch may be used.

10. POSTBRAZE INSPECTION.
(See Figures 1, 2, and 3 and Table 4.)

a. Acceptance limits are given in this paragraph for brazed joints by visual inspection, X-ray inspection, metallographic examination and pressure testing (tube and manifold assemblies).

b. General visual inspection standards.

(1) No magnification is required for visual inspection.

(2) End of joint where brazing alloy was introduced shall show complete line or ring of braze between joint members.

(3) When end of joint opposite where braze was applied can be inspected, at least a metallic stain of brazing alloy shall be visible, as evidence of complete penetration.

(4) Surface of parts shall be free from excess braze, burning, scaling, or cracking.

(5) Pits no greater than 0.031 inch in diameter and depth are acceptable. Any number of such pits are acceptable in fillets of brazed joints.

(6) Butt joints. Buildup of braze on introduction side shall not exceed 100% of material thickness. Buildup of braze on opposite side shall not exceed 50% of material thickness. Number of pits no greater than 0.031 inch in diameter and depth shall not exceed one per 0.125 inch of braze.

c. Specific acceptance limits for vane-to-shroud braze fillets.

(1) For vane-to-shroud braze fillets in gaspath of compressor inlet guide, or first or second stage vane and shroud assembly, no pits larger than 0.062 inch diameter are acceptable.

(2) Any number of pits 0.062 inch diameter or less are acceptable.

d. Specific acceptance limits for brazed joints on woven wire and perforated metal parts.

(1) Requirement for complete line of braze as in paragraph 10.a.(2) shall not apply to openings in wire cloth or to holes in perforated metal.

(2) Braze alloy or stain may extend beyond joint provided material thickness is not increased by more than 0.002 inch, and width of braze beyond joint is not more than five times the thickness of the thinnest material.

(3) Any number of pits no greater than 0.031 inch in diameter and depth are acceptable in brazed areas between wires or in perforations.

NOTE

Fillet leg refers to the distance from root of joint to edge of braze deposit. Root of joint is the point of nearest approach of parts to be brazed.

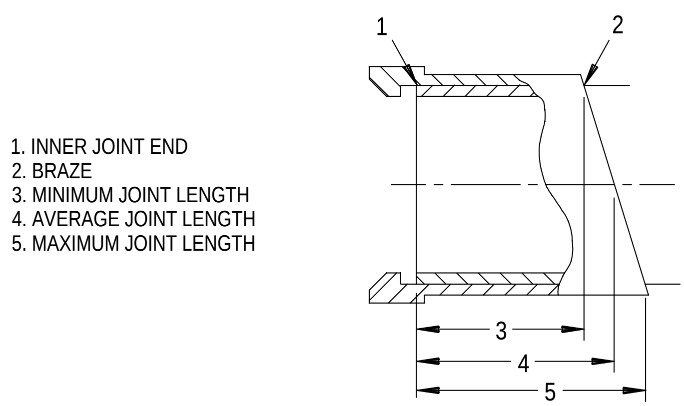
(4) Where woven wire cloth is brazed either to solid, or to perforated sheet, a fillet of braze material is acceptable, provided fillet leg does not exceed five times the thickness of the wire cloth.

e. X-ray inspection. The following standards apply when at least 70% of brazed joint can be X-ray inspected.

NOTE

To calculate mating area, use minimum joint dimensions provided in WP/SWP.

(1) Brazing alloy shall occupy entire joint length, and fill that length to at least 80% of mating area, or as specified per WP/SWP. (See figures 1 and 2.)



JA92 (18X2)

Figure 1. X-ray Inspection of Brazed Joint Area

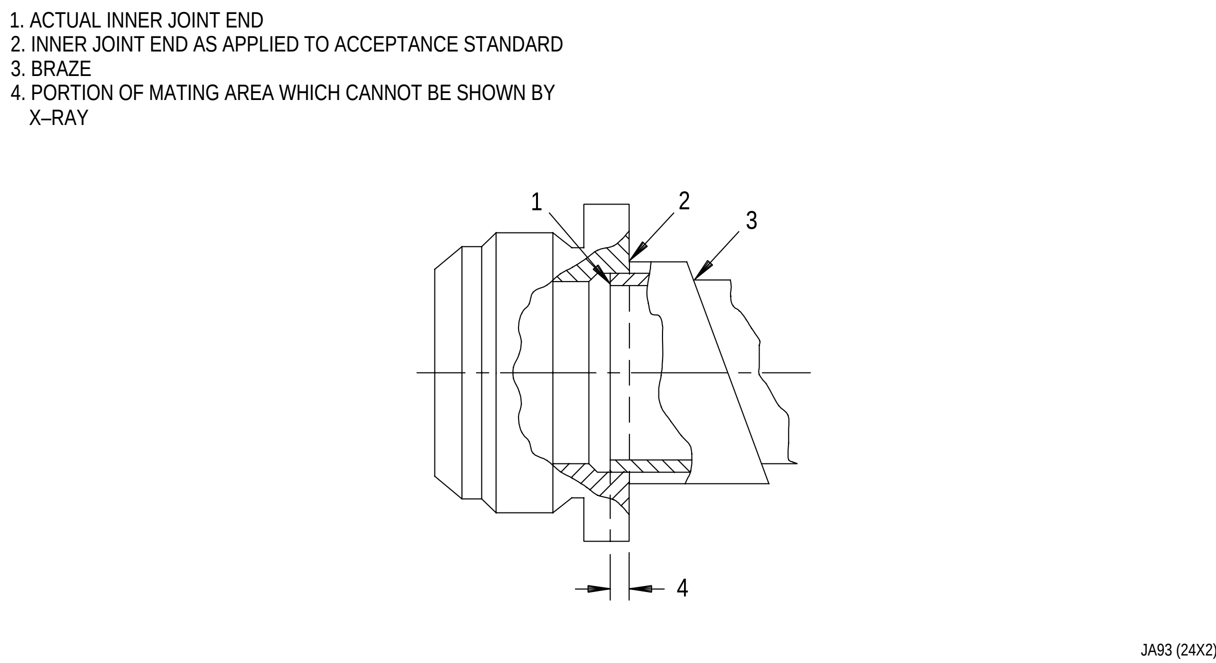


Figure 2. X-ray Inspection of Brazed Joint Area

(2) Voids shall be separated from one another by at least 0.015 inch; otherwise they shall be considered as one void. Axial dimension shall be determined from (combined) projections along joint axis.

(3) For tube and manifold assemblies, the following additional requirements shall be satisfied:

(a) Axial length of void, except for type of joint shown in figure 3, shall be no more than 90% of minimum joint length.

(b) For joints of type shown in figure 3, a void starting from inner joint end shall be separated from outer joint end by at least 0.030 inch. If void starts from one of outer joint ends, it shall be separated from inner joint by 0.030 inch.

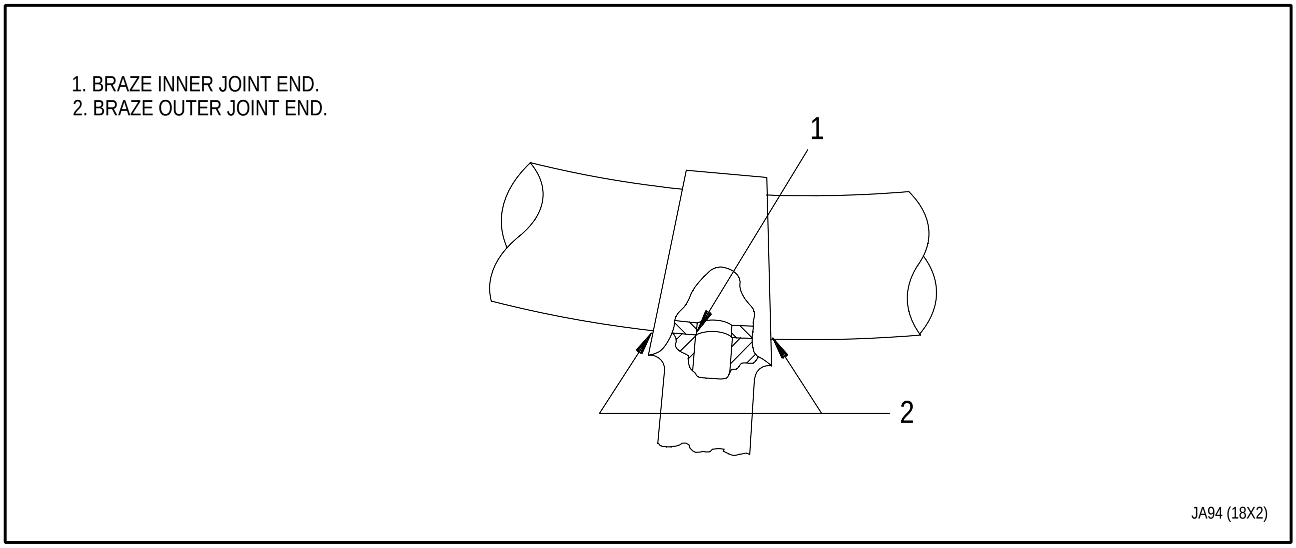


Figure 3. X-ray Inspection of Brazed Joint Area

f. Metallographic examination (gold-nickel brazed joints only).

(1) Representative test specimen shall show no more than 0.004 inch depth of alloying from original parent metal surface at each joint, unless otherwise specified per WP/SWP.

(2) Representative test specimen shall show no more than 0.002 inch undercutting, or 0.004 inch total combined depth of undercutting plus depth of alloying.

g. Pressure testing.

WARNING

Do not use compressed air or gas for pressure test because of possible explosive nature of failures.

CAUTION

For parts subject to corrosion, add corrosion-inhibiting water conditioner to tap water in ratio of 1:150, for hydraulic pressure testing.

NOTE

Leaks may be checked and located by pressurizing parts to 10 psi maximum with air, and immersing in a water tank. Do NOT confuse this with the hydraulic testing, which is done with water or oil pressure only.

(1) Apply hydraulic test to all tube and manifold assemblies following any braze or heat repair, using tap water or mineral seal oil.

(2) Unless otherwise specified per WP/SWP, hold test pressure per table 4 according to parts usage, for minimum of 1 minute. No leakage in any amount, or deformation due to test pressure, is acceptable.

Table 4. Hydraulic Test Pressures

Part	Pressure Test, psi
Pressurized Fuel Tubes	1200
Fuel Drain Tubes	100
Oil Pressure and Scavenge Lines	150
Breather Tubes	100
Air Tubes	350
Water Tubes	500
Flat Tubes in Inlet Cases	175
Round Tubes in Inlet Cases	350
Natural Gas Tubes	450

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BRAZING, SILVER

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 12	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Plating, Nickel, on Stainless Steel, Nickel, or Cobalt (SPOP 26)	SWP 092 10
Stripping Silver or Copper Brazing Alloy from Corrosion and Heat Resistant Steel (SPOP 305)	SWP 092 25
Brazing, General	WP 094 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification
Brazing alloy, silver, AMS 4765 (PWA 707)	Silvaloy T-562 56% silver; 42% copper; 2% nickel
Brazing alloy, silver, AMS 4770	QQ-B-654, Grade IV 50% silver; 18% cadmium; 16.5% zinc; 15.5% copper
Brazing alloy, silver, AMS 4772	54% silver; 40% copper; 5% zinc; 1% nickel
Brazing alloy, silver, PWA 706	Wesgo Palcusil No. 25 or CKT-1740-852 54% silver, 25% palladium; 21% copper
Brazing alloy, silver, PWA 715	48.5% silver; 22.5% palladium; 19% copper; 10% nickel
Brazing binder	Nicrobraz No. 300 cement or Acryloid B-7

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Flux, silver brazing, high temperature, AMS 3411	-
Flux, silver brazing, high temperature, PWA 809	Hi-Temp White Flux
Flux, silver brazing, low temperature, AMS 3410	O-F-499
Nickel powder	Inco 122
Nitric acid	O-N-350
Silver nitrate	-
Stop-off compound, brazing	Nicrobraz Green Stop-off or Stix
Corrosion inhibitor water conditioner	Reilly-Whiteman X74-26A

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance silver brazing.

2. SURFACE PREPARATION.

NOTE

Old silver braze may be chemically stripped. Refer to SWP 092 25 when specified per WP/SWP.

a. Surfaces to be joined shall be clean, but not highly polished.

CAUTION

Do not use aluminum oxide-type abrasives, as in ordinary emery cloth, for preparation of surfaces to be brazed. Traces of aluminum or compounds of aluminum interfere with proper flow of molten braze alloy.

b. A suitable surface finish may be obtained with No. 320 grit silicon carbide cloth. For tubes with an OD 0.375 inch or greater, clean tube OD and fitting ID lightly. This produces satisfactory capillary flow of molten braze alloy.

c. Degrease parts. Refer to SWP 031 01, steps 2.a. through 2.e., allowing 3 to 5 minutes in vapor.

3. PREBRAZE NICKEL PLATING REQUIREMENT.

(See Table 1.)

a. Unless otherwise specified per WP/SWP, parts to be silver brazed per AMS 2664 of PWA 85 by vacuum furnace or by induction or furnace methods in a protective atmosphere, shall be nickel plated to the thicknesses listed in table 1. Refer to SWP 092 10.

b. For additional process requirements, refer to WP 094 00.

c. Prior to joining, nickel plated parts shall be diffusion treated by heating to 1775° to 1875°F (968° to 1024°C) and held at heat for at least 10 seconds.

- Exception: For parts to be furnace brazed, this requirement is waived.

Table 1. Prebraze Nickel Plate Thicknesses

Alloy to be Brazed	Plate Thickness, Inch
AISI 321	0.0001 to 0.0003
Inch 17-7PH AM-363 A-286 PH 15-7Mo Custom 455	0.0004 to 0.0006 (Note 2)
Inconel 706 Inconel 718 Inconel X-750 Incoloy 901	0.0004 to 0.0006 (Note 2)
Waspaloy Astroloy Udimet 500 Udimet 700 IN-100 Inconel 713 Mar-M200 B-1900 NX-188 Inconel 738 Inconel 792	0.0008 to 0.0012 (Note 2)
Inconel 600 Inconel 625 Hastelloy N	0.0001 to 0.0003

NOTE 1. For alloys other than those listed, 0.0001 to 0.0003 inch may be used.

NOTE 2. For brazing by vacuum furnace, 0.0001 to 0.0003 inch may be used.

4. FLUXING.

CAUTION

When brazing in a vacuum or protective atmosphere, flux shall not be used unless specifically permitted per WP/SWP.

a. Unless otherwise specified per WP/SWP, apply AMS 3410 flux, completely coating surfaces to be joined, when brazing per AMS 2665 by torch or induction method (low temperature silver braze).

b. Apply AMS 3411 or PWA 809 flux, completely coating surfaces to be joined, when brazing per AMS 2664 by torch or induction method (high temperature silver braze).

c. Apply AMS 3411 flux, completely coating surfaces to be joined, when brazing per AMS 2666 by torch or induction method (high temperature silver braze).

d. Following application of flux, when brazing is to be done by the combustible torch method, do not expose prepared surfaces to atmosphere any longer than required for assembly/fixturing parts for brazing.

5. ASSEMBLY.

CAUTION

Do not allow stop-off compound to cover braze material, or get into joints to be brazed.

a. Stop-off compound may be applied to parts or fixtures to prevent brazing alloy from flowing into prohibited areas.

b. When parts to be brazed have been nickel plated, assemble so that clearance between mating surfaces is within part tolerance.

(1) A clearance of 0.0015 inch on a side is desirable.

(2) For tube-to-fitting joints, 0.0015 to 0.005 inch loose is the recommended fit.

(3) Support assembly in such a way that parts will be in correct alignment following brazing.

6. BRAZING.
(See Table 2.)

a. For additional process requirements, refer to T.O. 2J-F100-53-1, WP 094 00.

b. Materials. Unless otherwise specified per WP/SWP, silver brazing processes shall use the following materials:

(1) AMS 4770 low temperature silver braze alloy, when used for AMS 2665 torch or induction brazing with flux.

(2) AMS 4772 high temperature silver braze alloy, when used for AMS 2666 brazing, or for AMS 2664 brazing with flux.

(3) AMS 4765 (PWA 707) high temperature silver braze alloy, when used for AMS 2664 furnace or induction brazing in a protective atmosphere, for parts of nonhardenable alloys or unhardened steels or alloys.

(4) PWA 706 high temperature silver braze alloy, when used for PWA 85 furnace brazing in a protective atmosphere, for parts composed of hardenable alloys, such as AMS 5504 or AMS 5613 (AISI Type 410 steel), where hardening is accomplished during a modified furnace braze cycle.

(a) Tube assemblies require wire or strip form of PWA 706.

(b) Store silver brazing paste materials at 35° to 45°F (2° to 7°C), and 25 to 30% relative humidity.

(c) Applications other than tube assemblies may use powder form of PWA 706 in combination with acryloid cement, as permitted per WP/SWP.

(5) PWA 715 high temperature silver braze alloy may be used in combination with acryloid cement for PWA 85 furnace brazing of vane and shroud assemblies, or other parts for which brazing paste is permitted per WP/SWP.

(6) PS 142 Silver-Copper-Palladium alloy powder plus Inco 122 nickel powder and acryloid cement brazing binder may be used for PWA 85 furnace brazing of vane and shroud assemblies. The inclusion of nickel powder results in improved gap filling. For preparation of PS 142, see table 2.

Table 2. Preparation of PS 142 Brazing Alloy

Braze Alloy Designation	Compostion		Preparation Procedure
	Material	Make-up Limts, %	
PS 142 Silver-Copper-Palladium Alloy Powder plus Nickel Powder and Binder Mixture	Silver-Copper-Palladium Alloy Powder, PWA 706 Inco 122 nickel powder Binder: Nicrobraz #300 Cement or Acryloid B-7	83 to 87 13 to 17 As required	Metal Mixture: 1. Mix 85 parts by weight of PWA 706, with 15 parts Inco 122 nickel powder. Do not mix more than 15 to 20 ounces. Store in tightly covered glass jar. Paste: 1. Prepare paste immediately prior to use. 2. Add sufficient binder to not more than 3 to 4 ounces of metal mixture, to form a paste. 3. If paste becomes too sticky, add more binder.

c. Joining procedure.

(1) Sufficient brazing alloy shall be placed within or adjacent to joint to be brazed.

d. Unless otherwise specified per WP/SWP, joining shall be accomplished using flux with induction or torch method, or without flux, using vacuum furnace, or using furnace or induction method with protective atmosphere.

CAUTION

Hardenable alloys would be excessively hardened, if given only a furnace braze cycle. Parts made of these materials shall receive a complete heat treatment cycle, including tempering, precipitation heat treatment, etc. after the brazing cycle, in order to be transformed to the desired physical condition.

NOTE

Hardening during furnace brazing is a special procedure not usually accomplished at routine repairs. When this procedure is applicable, it shall be so specified per WP/SWP, and cooling shall be at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

e. Parts shall be heated until brazing alloy melts, and the joint is formed. Avoid further heating. For PWA 706 braze alloy, brazing temperature shall be 1800° to 1850°F (982° to 1010°C). For all other silver braze alloys, temperature shall not exceed 1950°F (1066°C).

f. Furnace brazing shall not be used on tube assemblies if silver plated or aluminum nuts or other aluminum detail parts have previously been installed.

g. Furnace brazing shall not be used when parts have previously been hardened, unless so directed by WP/SWP, and rehardening information is included in repair procedure.

7. COOLING.

a. Assemblies shall be cooled in such a way as to prevent cracks, and to reduce as much as possible, the following:

b. Internal stress.

c. Distortion.

d. Oxidation.

e. Decarburization.

f. Scaling.

8. FLUX REMOVAL.

CAUTION

Remove all traces of brazing flux from all surfaces. Any residual flux can later cause corrosion cracking.

a. Flux removal method shall not be injurious to any specified surface finish.

b. Tube assemblies shall be thoroughly cleaned inside and outside to assure complete flux removal.

CAUTION

No aluminum part, or part containing an aluminum detail part, shall be washed in alkali solution. Hot water only shall be used for aluminum.

c. Remove loose scale formed as a result of brazing with a stiff wire brush.

d. Wash parts thoroughly for 5 minutes in either PS 206 or PS 214 alkali cleaner, heated to 170° to 190°F (77° to 88°C). Refer to T.O. 2-1-111 for solution preparation and maintenance.

e. Rinse parts thoroughly in clean, hot water. Ensure that all alkali solution is rinsed out, especially in areas where it might have been entrapped.

f. For parts subject to corrosion or rusting, such as carbon steel, low alloy steel, martensitic or ferritic stainless steel, add corrosion-inhibiting water conditioner to tap water in ratio of 1 to 2 ounces per gallon, unless otherwise specified in WP/SWP.

g. If hot alkali solution is not available, wash (with agitation) in clean, hot water for a minimum of 5 minutes.

h. Air blast to dry.

i. Ensure that all traces of flux are removed, using Method A or Method B in paragraph 9.

9. RESIDUAL FLUX DETECTION.
(See Table 3.)

a. Method A or Method B shall be used for tube, manifold, probe, bellows, thermocouple, or hose assemblies, or any other assemblies when required by WP/SWP. Each assembly need not be tested, but sufficient representative parts shall be tested, so as to assure that flux has been properly removed from all assemblies.

b. Method A.

(1) Soak part at least five minutes in small amount of distilled or demineralized water. Use smallest quantity of water which will wet all surfaces where brazing flux was used. Pay special attention to inside of tube assemblies.

(2) Remove part from water. Be sure water from inner cavities is drained into soak water, and not lost.

(3) Partially fill a test tube with sample of soak water.

(4) Add 3 to 5 drops of O-N-350 concentrated nitric acid to test tube with soak water sample.

WARNING

Silver nitrate is poisonous. Protect eyes and skin from contact.

(5) Prepare silver nitrate halide test solution (PS 262) per table 3.

Table 3. Preparation of PS 262 Silver Nitrate Solution

Solution Designation	Compostion		Preparation
	Material	Make-up	
PS 162 Sivler Nitrate - Halide Test Solution	Silver nitate crystals Distilled (or Demineralized) Water	68 grams 1 gallon	1. Fill a clean, one-gallon brown glass jug half full with distilled water. 2. Add 68 grams of silver nitrate crystals. Shake until dissolved. 3. Fill jug with distilled water. Store preferably in dark.

(6) Add 20 drops of PS 262 silver nitrate solution to acidified soak solution sample in test tube.

(7) Add 20 drops of PS 262 silver nitrate solution to a second test tube containing only distilled water, as a control for comparison. Control should not show any cloudiness or white precipitate.

(8) Presence of a white precipitate or cloudiness indicates the presence of brazing flux. Cleaning per paragraph 8 and flux detection per paragraph 9 shall be repeated until test is negative.

c. Method B.

(1) Rinse braze area with approximately 200 ml of demineralized or distilled water at 180°F (82°C) and collect washings in a suitable container.

(2) Determine presence of fluoride (present in flux) in washings by using the Hach Chemical Fluoride Test Kit, Model No. FL-3, available from the Hach Chemical Co, P.O. Box 907, 713 South Duff, Ames, IA 50010, or equivalent test apparatus.

(3) If a positive test for fluoride is obtained, cleaning and this test shall be repeated until fluorides are no longer detected.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BRAZING, GOLD NICKEL, AND NICKEL-PHOSPHORUS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3) - - - - - - - - - - - - - - -	SWP 031 01
Plating, Nickel, on Stainless Steel, Nickel, or Cobalt (SPOP 26) -	SWP 092 10
Plating, Electroless Nickel (SPOP 309) - - - - - - - - - - - -	SWP 092 28
Brazing, General -	WP 094 00
Brazing, Silver -	SWP 094 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Brazing alloy, gold-nickel, (AMS 4787)	Wesgo 2010 or CKT-1742-854 82% gold; 18% nickel
Brazing, alloy, gold-nickel, (PWA 728)	70% gold; 30% nickel
Brazing binder	Nicrograz No. 300 cement
Grit, steel	MIL-S-851
Nickel power	Inco 122
Stop-off compound, brazing	Nicrobraz Green Stop-off or Stix

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance gold-nickel and nickel-phosphorous brazing procedures.

2. GOLD-NICKEL BRAZING PROCESS.
(See Tables 1 and 2.)

a. Surface preparation. Refer to T.O. 2J-F100-53-1, WP 094 00 and observe the following:

(1) Surfaces to be joined shall be descaled or deoxidized, if necessary, and thoroughly cleaned by suitable means.

(2) For joints not to be prepared by nickel plating, a surface finish of 125 microinches is desirable but not required.

CAUTION

Do not use aluminum oxide-type or titanium-bearing abrasives, as in ordinary emery cloth, for preparation of surfaces to be brazed. Traces of aluminum or compounds of aluminum or titanium interfere with proper flow of molten braze alloy.

(3) A suitable surface finish may be obtained with No. 320 grit silicon carbide cloth. For tubes with an OD 0.375 inch or greater, clean tube OD and fitting ID lightly. This produces satisfactory capillary flow of molten braze alloy.

(4) If surfaces are prepared by blasting, use MIL-S-851 steel grit, size 120 to 50. Grit shall be clean and, if used previously, used only for similar cleaning.

(5) Degrease parts per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., allowing 3 to 5 minutes in vapor.

(6) Prior to assembly, cleaned parts shall be protected from dust or other contamination.

(7) Prior to brazing, clean gloves shall be worn when handling parts, tools, and brazing materials.

b. Prebraze nickel plating requirement. Unless otherwise specified per WP/SWP, parts to be gold-nickel brazed per PWA 19 by vacuum furnace or by induction or furnace methods in a protective atmosphere, shall be nickel plated per T.O. 2J-F100-53-1, SWP 092 10 to the thicknesses listed in table 1.

c. Prior to joining, nickel plated parts shall be diffusion treated by heating to 1775° to 1875°F (968° to 1024°C) and held at heat for at least 10 seconds.

Exception: For parts to be furnace brazed, this requirement is waived.

d. Flux shall not be used unless specifically permitted per WP/SWP. In that case, following brazing and postcleaning, flux removal and testing procedures per T.O. 2J-F100-53-1, SWP 094 01 shall be required.

Table 1. Prebraze Nickel Plate Thicknesses

Alloy to be Brazed (Note 1)	Plate Thickness, Inch
AISI 321	0.0001 to 0.0003
17 - 7PH AM-363 PH 15-7Mo Custom 455	0.0004 to 0.0006 (Note 2)
Inconel 706 Inconel 718 Inconel X-750 Incoloy 901	0.0004 to 0.0006 (Note 2)
Waspaloy Astroloy Udimet 500 Udimet 700 IN-100 Inconel 713 Mar-M200 B-1900 NX-188 Inconel 738 Inconel 792	0.0008 to 0.0012 (Note 2)
Inconel 600 Inconel 625 Hastelloy N	0.0001 to 0.003

Note 1. For alloys other than those listed, 0.0001 to 0.0003 inch may be used.

Note 2. For brazing by vacuum furnace, 0.0001 to 0.0003 inch may be used.

e. Assembly.

CAUTION

Do not allow stop-off compound to cover braze material, or get into joints to be brazed.

(1) Stop-off compound may be applied to parts or fixtures to prevent brazing alloy from flowing into prohibited areas.

(2) When parts to be brazed have been nickel plated, assemble so that clearance between mating surfaces is within part tolerance.

(a) A clearance of 0.0015 inch on a side is desirable.

(b) For tube-to-fitting joints, 0.0015 to 0.005 inch loose is the recommended fit.

(c) Support assembly in such a way that parts will be in correct alignment following brazing.

f. Brazing materials.

(1) Unless otherwise specified per WP/SWP, brazing material shall be AMS 4787.

(2) Tube assemblies require wire or strip form of AMS 4787.

NOTE

(3) Store gold-nickel brazing paste materials at 35° to 45°F (2° to 7°C) and 25 to 30% relative humidity.

(4) Applications other than tube assemblies may use powder form of AMS 4787 in combination with acryloid cement, as permitted per WP/SWP.

(5) PWA 718 gold-nickel braze alloy may be used in combination with acryloid cement for PWA 19 brazing of vane and shroud assemblies, or other parts for which brazing paste is permitted per WP/SWP.

Table 2. Preparation of PS 109 Brazing Alloy

Braze Alloy Designation	Composition		Preparation Procedure
	Material	Make-up Limits, %	
PS 109 Gold-Nickel Powder plus Nickel Powder and Binder Mixture	Gold-Nickel Alloy Power, AMS 4787	85 to 90	Metal Mixture: 1. Mix 85 parts by weight of AMS 4787, with 15 parts Inco 122 nickel power. Do not mix more than 15 to 20 ounces at a time. 2. Store in tightly covered glass jar. Paste: 1. Prepare paste immediately prior to use. 2. Add sufficient binder to not more than 3 to 4 ounces, of metal mixture, to form a paste. 3. If paste becomes sticky, add more binder.
	Inco 122 nickel powder	10 to 15	
	Binder: Nicrobraz #300 Cement	As required	

(6) PS 109 gold-nickel alloy powder plus Inco 122 nickel powder and acryloid cement brazing binder may be used for PWA 19 brazing of vane and shroud assemblies. The inclusion of nickel powder results in improved gap filling. For preparation of PS 109, see table 2.

g. Joining procedure:

(1) Sufficient brazing alloy shall be placed within or adjacent to joint to be brazed.

CAUTION

Hardenable alloys would be excessively hardened, if given only a furnace braze cycle. Parts made of these materials shall receive a complete heat treatment cycle, including tempering, precipitation heat treatment, etc. after the brazing cycle, in order to be transformed to the desired physical condition.

(2) For alloys hardenable by heat treatment, heating shall be done in a furnace with suitable protective atmosphere. For information on protective atmospheres, refer to T.O. 2J-F100-53-1, WP 094 00. Unless otherwise specified per WP/SWP, furnace brazing temperature shall be 1800° to 1850°F (982° to 1010°C). Time at heat shall be 7 to 30 minutes.

(3) Furnace brazing shall not be used on tube assemblies if silver plated or aluminum nuts or other aluminum detail parts have previously been installed.

(4) Furnace brazing shall not be used when parts have previously been hardened, unless so directed by WP/SWP, and rehardening information is included in repair procedure.

(5) Alloys not hardenable by heat treatment may be brazed in a furnace, or by induction heating using a suitable protective atmosphere surrounding work. Refer to T.O. 2J-F100-53-1, WP 094 00. Unless otherwise specified per WP/SWP, brazing temperature range shall be 1800° to 1950°F (982° to 1066°C), except that for PWA 1040 and PWA 1069 materials (Inconel 625), brazing temperature shall be 1800° to 1850°F (982° to 1010°C). Parts shall be heated until brazing alloy melts, and the joint is formed. Avoid further heating.

h. Cooling.

(1) Assemblies shall be cooled in such a way as to prevent cracks, and to reduce as much as possible internal stress, distortion, oxidation, and decarburization.

(2) Cooling from brazing temperature to below scaling temperature shall be done in a protective atmosphere.

(3) Scaling shall be absent, but discoloration is permitted.

(4) Hardening during furnace brazing is a special procedure not usually accomplished at routine repairs. When this procedure is applicable, it shall be so specified per WP/SWP, and cooling shall be at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute, or faster.

3. NICKEL-PHOSPHORUS BRAZING OF ALLOY FIBER METAL SHEET, PER PWA 34.

a. General. When fiber metal is to be brazed to a solid surface part, the solid surface brazing area is first electroless nickel plated; then the fiber metal sheet is positioned over the plated area and furnace brazed. The nickel plate serves as the filler material in the brazing process.

b. Procedure.

(1) Remove worn and/or damaged fiber metal seal by machining. Do not thin basis material.

(2) Electroless nickel plate braze area on solid surface per T.O. 2J-F100-53-1, SWP 092 28 to thickness specified per WP/SWP.

(3) Assemble fiber metal sheet to part and secure into position. Ensure alloy fiber metal sheet is not excessively crushed.

(4) Furnace braze in protective atmosphere at 1750° to 1850°F (954° to 1010°C). Time at heat shall be 7 to 30 minutes.

(5) After brazing, alloy fiber metal sheet shall not be reduced in thickness more than 3% of original thickness, assuming zero braze layer thickness.

CAUTION

- Depth of braze alloying into basis metal, including intergranular penetration at the joint, shall not exceed 0.004 inch when measured from original parent metal surface.
- Braze alloy penetration into fiber metal sheet shall not exceed 0.010 inch.

(6) Heat treat in furnace using protective atmosphere at time and temperature specified by WP/SWP. Cool in protective atmosphere to below scaling temperature.

(7) Cooling of hardenable alloys shall be at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

(8) Following brazing and heat treatment, when required by the WP/SWP, provide an oxidation cycle by heating to 1190° to 1210°F (643° to 654°C), holding for 2 hours in air, then air-cooling.

(9) Inspect for satisfactory bonding. Unless otherwise specified per WP/SWP, area joined by brazing alloy shall be not less than 80% of area of mating portions of assembly.

(10) Subsequent to brazing operation, any thermal treatment above 1225°F (663°C) shall be done in furnace using protective atmosphere.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - BRAZING, VACUUM FURNACE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 10	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Plating, Nickel, on Stainless Steel, Nickel, or Cobalt (SPOP 26)	SWP 092 10
Brazing, General	WP 094 00
Brazing, Silver	SWP 094 01
Brazing, Gold-Nickel or Nickel-Phosphorous	SWP 094 02

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Grit, steel	MIL-S-851
Stop-off compound, brazing	Nicrobraz Green Stop-off or Stix

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance vacuum furnace brazing. (Refer to T.O. 2J-F100-53-1, WP 094 00, SWP 094 01, and 094 02.)

2. GENERAL.

CAUTION

Furnace brazing shall not be used when parts have previously been hardened, unless so directed by WP/SWP, and rehardening information is included in repair procedure.

a. Steel or heat and corrosion resistant alloy parts may be vacuum furnace brazed.

b. Parts may be heat treated during furnace braze cycle if so required or permitted per WP/SWP.

c. Furnace brazing shall not be used on tube assemblies if silver plated or aluminum nuts or other aluminum detail parts have previously been installed.

d. Nickel brazing tape and paste materials shall be stored at 35° to 45°F (2° to 7°C), and 25 to 30% relative humidity.

e. Argon gas may be introduced to help cooling, after vacuum furnace brazing with nickel, nickel-phosphorus, gold-nickel, or high temperature silver brazing per PWA 85.

f. When silver brazing per PWA 85 using PWA 706 brazing material, or other brazing using an alloy subject to vaporization under high vacuum, argon may be introduced to maintain an inert partial pressure during heating of parts and for remainder of cycle.

3. SURFACE PREPARATION.

a. Surfaces to be joined shall be descaled or deoxidized, if necessary, and thoroughly cleaned by suitable means.

b. For joints not to be prepared by nickel plating, a surface finish of 125 micro inches is desirable but not required.

CAUTION

Do not use aluminum oxide-type or titanium-bearing abrasives, as in ordinary emery cloth, for preparation of surfaces to be brazed. Traces of aluminum or compounds of aluminum or titanium interfere with proper flow of molten braze alloy.

c. A suitable surface finish may be obtained with No. 320 grit silicon carbide cloth. For tubes with an OD 0.375 inch or greater, clean tube OD and fitting ID lightly. This produces satisfactory capillary flow of molten braze material.

d. If surfaces are prepared by blasting, use MIL-S-851 steel grit, size 120 to 50. Grit shall be clean and, if used previously, used only for similar cleaning.

e. Degrease parts per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.

f. Prior to assembly, cleaned parts shall be protected from dust or other contamination.

g. Prior to brazing, clean gloves shall be worn when handling parts, tools, and brazing materials.

4. PREBRAZE NICKEL PLATING REQUIREMENT.
(See Table 1.)

a. When using PWA 996 nickel brazing alloy, prebraze nickel plating is required for satisfactory braze flow, regardless of composition of parts to be joined.

b. Unless otherwise specified per WP/SWP, joints of alloys listed in table 1 shall be prepared in areas to be brazed, by nickel plating per T.O. 2J-F100-53-1, SWP 092 10.

c. For alloys other than those listed, 0.0001 to 0.0003 inch nickel plate thickness may be used

Table 1. Prebraze Nickel Plate Thicknesses

Alloy to be Brazed	Plate Thickness, Inch
AISI 321	0.0001 to 0.0003
17 - 7PH AM-363 A-286 PH 15-7Mo Custom 455	0.0004 to 0.0006 (Optional: 0.0001 to 0.0003)
Inconel 706 Inconel 718 Inconel X-750 Incoloy 901	0.0004 to 0.0006 (Optional: 0.0001 to 0.0003)
Waspaloy Astroloy Udimet 500 Udimet 700 IN-100 Inconel 713 Mar-M200 B-1900 NX-188 Inconel 738 Inconel 792	0.0008 to 0.0012 (Optional: 0.0001 to 0.0003)
Inconel 600 Inconel 625 Hastelloy N	0.0001 to 0.0003

5. ASSEMBLY.

CAUTION

Do not allow stop-off compound to cover braze material, or get into joints to be brazed.

a. Stop-off compound may be applied to parts or fixtures to prevent brazing alloy from flowing into prohibited areas.

b. When parts to be brazed have been nickel plated, assemble so that clearance between mating surfaces is within part tolerance.

(1) A clearance of 0.0015 inch on a side is desirable.

(2) For tube-to-fitting joints, 0.0015 to 0.005 inch loose is the recommended fit.

(3) Support assembly in such a way that parts will be in correct alignment following brazing.

c. Sufficient brazing alloy shall be placed within or adjacent to joint to be brazed.

6. FURNACE LOADING AND EVACUATING.

a. Place parts and fixtures on furnace hearth. Load into furnace so that argon can circulate freely and degassing will not be hindered.

b. Attach one thermocouple at approximate center of load. Use additional thermocouples as required.

c. Evacuate furnace to one micron (mercury) or less. Valve off furnace from pump and check static leak rate. Leak rate shall be less than 20 microns per hour.

7. JOINING PROCEDURES.

(See Table 2.)

a. Braze heat cycles for the following process groups are outlined in this paragraph.

Table 2. Braze Heat Cycles

Brazing Process	Braze Alloy
PWA 19	-
PWA 34	-
PWA 85	-
AMS 2675	AMS 4779 AMS 4782 AMS 4783
AMS 2675	AMS 4777 AMS 4778 PWA 1181
AMS 2675	PWA 996
AMS 2664	AMS 4765

CAUTION

Hardenable alloys would be excessively hardened, if given only a furnace braze cycle. Parts made of these materials shall receive a complete heat treatment cycle, including tempering, precipitation heat treatment, etc. after the brazing cycle, in order to be transformed to the desired physical condition.

b. Brazing to PWA 19 gold-nickel or PWA 34 nickel-phosphorus.

(1) Using furnace chart temperature/pressure recorder as a reference, heat furnace to 1175° to 1225°F (635° to 663°C) and hold for 10 minutes or until pressure of one micron is re-established.

(2) Heat furnace to 1575° to 1625°F (857° to 885°C) and hold for 45 minutes.

(3) For hardenable alloys per PWA 19 or PWA 34, heat furnace to 1800° to 1850°F (982° to 1010°C). When charge reaches this temperature, using work thermocouple as a reference, hold at heat for 15 to 30 minutes, then shut off heat.

(4) For nonhardenable alloys per PWA 19 gold-nickel, heat furnace to 1800° to 1950°F (982° to 1066°C), as required. When charge reaches required temperature, using work thermocouple as a reference, hold at heat until braze alloy melts and the joint is formed. Avoid further heating.

Exception: PWA 1040 and PWA 1069 (Inconel 625) shall be brazed at 1800° to 1850°F (982° to 1010°C).

(5) For nonhardenable alloys per PWA 34 nickel-phosphorus, heat furnace to 1810° to 1840°F (988° to 1004°C). When charge reaches required temperature, using work thermocouples as a reference, hold at heat 15 to 30 minutes, then shut off heat.

c. Brazing to PWA 85 high temperature silver.

(1) Using furnace chart temperature/pressure recorder as a reference, heat furnace to 1175° to 1225°F (635° to 663°C), and hold for 10 minutes or until pressure of one micron is re-established.

(2) Introduce argon gas to a pressure of 1.00 millimetre and maintain throughout heat-up cycle.

(3) Heat furnace to 1525° to 1575°F (829° to 857°C) and hold for 20 minutes.

(4) Heat furnace to 1800° to 1850°F (982° to 1010°C). When charge reaches this temperature, using work thermocouple as a reference, hold at heat for 15 to 30 minutes, then shut off heat.

d. Brazing to AMS 2675 nickel using AMS 4779, AMS 4782, or AMS 4783 braze alloy.

(1) Using furnace chart temperature/pressure recorder as a reference, heat furnace to 975° to 1025°F (524° to 552°C), and hold for 10 minutes or until pressure of one micron is re-established.

(2) Heat furnace to 1675° to 1725°F (913° to 941°C) and hold until stabilized.

(3) For AMS 4779 braze material, heat rapidly to 2050° to 2100°F (1121° to 1149°C), hold for 7 to 10 minutes, then shut off heat.

(4) For AMS 4782 braze material, set furnace initially at 2180° to 2220°F (1193° to 1216°C). When highest-reading work thermocouple reaches 2080° to 2120°F (1138° to 1160°C), reduce voltage and hold at 2100° to 2150°F (1149° to 1177°C) for 7 to 10 minutes, then shut off heat.

(5) For AMS 4783 braze material, heat rapidly to 2100° to 2150°F (1149° to 1177°C), hold for 15 to 30 minutes, then shut off heat.

e. Brazing to AMS 2675 nickel using AMS 4777, AMS 4778, or PWA 1181 braze alloy.

(1) Heat to 775° to 825°F (413° to 441°C) at 15°F (8°C) per minute, and hold at heat until evacuated to 0.5 micron.

(2) Heat to 975° to 1025°F (524° to 552°C) at 15°F (8°C) per minute, and hold at heat until evacuated to 0.5 micron.

(3) Heat to 1675° to 1725°F (913° to 941°C) at 15°F (8°C) per minute, and hold at heat until evacuated to 0.5 micron.

(4) Heat to 1900° to 1950°F (1038° to 1066°C) and hold for 10 to 25 minutes, then shut off heat.

f. Brazing to AMS 2675 nickel using PWA 996 braze alloy.

(1) Evacuate furnace to less than 0.5 micron.

(2) Heat to 1175° to 1225°F (635° to 663°C), and hold at heat until work thermocouples stabilize and pressure of 0.5 micron is re-established.

(3) Heat to 1625° to 1675°F (885° to 913°C), and hold at heat until work thermocouples stabilize and pressure of 0.5 micron is re-established.

(4) Heat as rapidly as possible to 2060° to 2090°F (1127° to 1143°C), hold at heat for 20 to 30 minutes, then shut off heat.

(5) Furnace cool to 1525° to 1575°F (829° to 857°C).

(6) Fill system with argon gas and circulate in order to cool to below 700°F (371°C).

(7) If specified by WP/SWP as an option, cooling may continue with circulating argon until cooled below 300°F (149°C), then unload furnace. Otherwise, continue with remaining steps of cycle.

(8) Valve off furnace from argon supply, and evacuate to 0.5 micron.

(9) Heat to 1475° to 1525°F (802° to 829°C), and hold at heat until work thermocouples stabilize and pressure of 0.5 micron is re-established.

(10) Heat to 1775° to 1825°F (968° to 996°C), hold for 15 to 30 minutes, then shut off heat.

g. Brazing to AMS 2664 high temperature silver using AMS 4765 braze alloy.

(1) Using furnace chart temperature/pressure recorder as a reference, heat furnace to 1175° to 1225°F (635° to 663°C), and hold for 10 minutes or until pressure of one micron is re-established.

(2) Introduce argon gas to a pressure of 1.00 millimetre, and maintain throughout heat-up cycle.

(3) Heat furnace to 1525° to 1575°F (829° to 857°C) and hold at heat for 20 minutes.

(4) Heat furnace to 1825° to 1875°F (996° to 1024°C). When charge reaches this temperature, using work thermocouples as a reference, hold at heat for 15 to 30 minutes, then shut off heat.

8. COOLING AND UNLOADING.

a. PWA 19 gold-nickel and PWA 34 nickel-phosphorus only.

(1) Furnace cool under vacuum to approximately 1625° to 1675°F (885° to 913°C).

(2) Martensitic steel and precipitation hardenable alloys shall be cooled to 975° to 1025°F (524° to 552°C) at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

(3) Open dampers, introduce argon gas, and start recirculating system.

(4) Cool to below 300°F (149°C) before unloading.

b. PWA 85 high temperature silver only.

(1) Furnace cool to approximately 1625° to 1675°F (885° to 913°C), maintaining argon pressure at approximately 1.0 millimetre.

(2) Martensitic steel and precipitation hardenable alloys shall be cooled to 975° to 1025°F (524° to 552°C) at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

(3) Increase argon pressure to one atmosphere, and start recirculating system.

(4) Cool to below 300°F (149°C) before unloading.

c. AMS 2675 nickel.

NOTE

(1) Furnace cool PWA 996 braze alloy to 1525° to 1575°F (829° to 857°C).

(2) Furnace cool under vacuum to 1600° to 1700°F (871° to 927°C).

(3) Martensitic steel and precipitation hardenable alloys shall be cooled to 975° to 1025°F (524° to 552°C) at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

(4) Open dampers, introduce argon gas, and start recirculating system.

(5) Cool to below 300°F (149°C) before unloading.

d. AMS 2664 high temperature silver only.

(1) Furnace cool to 1525° to 1575°F (829° to 857°C) or as specified per WP/SWP, maintaining argon pressure at approximately 1.0 millimetre.

(2) Martensitic steel and precipitation hardenable alloys shall be cooled to 975° to 1025°F (524° to 552°C) at a rate equivalent to air-cool (approximately 20° to 30°F (11° to 17°C) per minute), or faster.

(3) Increase argon pressure to 1 atmosphere, and start recirculating system.

(4) Cool to below 300°F (149°C) before unloading.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - HEAT TREATMENT, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Plating, Cadmium (SPOP 21)	SWP 092 05
Heat Treatment: Solution, Stabilization, or Precipitation Cycles	SWP 095 01
Heat Treatment: Stress Relief Cycles	SWP 095 02

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, isopropyl	TT-I-735
Boron nitride coating/release agent	Type S-4D

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance heat treatment. Specific heat treat cycles are outlined in T.O. 2J-F100-53-1, SWP 095 01 and 095 02.

2. GENERAL.

(See Table 1.)

a. Controlled atmosphere ovens are not required for heat treatment unless specified per WP/SWP for a particular part.

b. A cold oven refers to an oven with temperature less than 500°F (260°C). Loading or unloading a cold oven may be done without further lowering the temperature, unless otherwise specified per WP/SWP.

c. Parts which are not susceptible to distortion during heat treatment may be loaded or unloaded from a hot oven.

d. Parts which are susceptible to distortion during heat treatment shall be adequately supported, and temperature raised stepwise. Cooling shall also be gradual. Stepwise cycles are identified by the Letter A following the cycle number.

e. Coat fixturing at part contact points and threads with Type S-4 boron nitride coating/release agent before installing part, and before heat treatment.

f. Time, temperature, and atmosphere determine a heat treatment.

(1) Time at a given temperature begins when all sections of parts have reached that temperature.

(2) Allowance is necessary for size of part, number of parts, and furnace input capacity.

(3) Basic temperatures are given, and in some cases, a tolerance is included to indicate desired precision for furnace control. Basic temperature is preferred.

(4) AIR COOL and AIR COOL OR FASTER mean that parts shall be cooled quickly enough to prevent metal structure changes which can happen in certain alloys if cooling is too slow. Do not liquid quench. A minimum cooling rate of 20° to 30°F (11° to 17°C) per minute to below 1000°F (538°C) is usually satisfactory. Circulating fans are permitted, but fixturing may be required in some cases to prevent distortion.

g. Stress-relief of Type 6A1-4V titanium alloy.

(1) Type 6A1-4V includes the following:

AMS 4911, AMS 4928, AMS 4930, AMS 4935, AMS 4954, AMS 4956, AMS 4965, AMS 4967, PWA 1213, PWA 1215 and PWA 1262.

(2) Stress-relief in air shall not exceed 1015°F ±15°F (546° ±8°C). Refer to Cycles 1 and 1A, T.O. 2J-F100-53-1, SWP 095 02.

(3) At temperatures higher than 1015°F (546°C), an inert atmosphere shall be used, regardless of any contrary instructions per WP/SWP.

h. Solution, stabilization, and precipitation heat treatments include the following Cycles: 12A, 15, 17, 20, 21, 101, 102, 103, 104, 105, 106 and 107. These cycles are outlined in T.O. 2J-F100-53-1, SWP 095 01.

i. Stress-relief heat treatments include the following Cycles: 1, 1A, 2, 3, 4, 4A, 5, 5A, 6, 6A, 7, 8, 9, 11, 13, 14 and 22. These cycles are outlined in T.O. 2J-F100-53-1, SWP 095 02.

j. Some typical material applications are listed in table 1 for general guidance only. A cross-reference is included, for convenience, to SPOP number in T.O. 2-1-111. Cycle(s) for which an alloy type is listed may not necessarily be used for that material, however, and shall be specified for individual repair per WP/SWP.

Table 1. Typical Heat Treatment Applications

Cycle No.	Type*	SPOP in T.O. 2-1-111	Possible Alloy Application
1, 1A	STR	455-1, 455-2	Low alloy steel, as AMS 6322 and AMS 6415; Chromium steel, as Type 410 (AMS 5504 and AMS 5613) and Greek Ascoloy (AMS 5508 and AMS 5616)
2	STR	456	Aluminum
3	STR	457	-
4, 4A	STR	458-1, 458-2	-
5, 5A	STR	459-1, 459-2	Nickel alloys: B-1900 (PWA 663 and PWA 1455); Inconel 713 (PWA 655) Cobalt alloys: Stellite 31 (AMS 5382); WI-52 (PWA 653); MAR-M509 (PWA 647)
6, 6A	STR	460-1, 460-2	Greek Ascoloy (AMS 5508 and AMS 5616) (chromium steel)
7	STR	461	Udimet 700 (nickel alloy)
8	STR	455-3	-
9	STR	459-3	Inconel 600 (nickel alloy); Nimonic 75 (PWA 673) (nickel alloy); stainless steel, as Types 310, 316, 321 and 347
11	STR	464	Titanium
12A	PRE	465	Inconel 718 (nickel alloy), as AMS 5596, AMS 5662 and AMS 5663
13	STR	466	17-7PH (stainless steel - austenite conditioning); Type 430 (chromium steel), welded with Type 430 filler metal
14	STR	467	Type 430 (chromium steel), welded with AMS 5680 (Type 347 stainless steel) or AMS 5776 (Type 410 chromium steel)
15	PRE	468	A-286 (modified Tinidur) stainless steel, as AMS 5525, AMS 5731, AMS 5732 and AMS 5737
17	PRE	470	Incoloy 901 (nickel alloy), as AMS 5660 and AMS 5661

Table 1. Typical Heat Treatment Applications (continued)

Cycle No.	Type*	SPOP in T.O. 2-1-111	Possible Alloy Application
20	SOL	480	Hastelloy X (nickel alloy)
21	SOL	481	Nickel alloy: Hastelloy X (AMS 5536 and AMS 5754) Cobalt alloys: Stellite 31 (AMS 5382); Haynes 188 (AMS 5608, AMS 5772, and PWA 1042); L-605 (AMS 5537 and AMS 5759)
22	STR	482	Nickel alloys: Inconel 600 (AMS 5540 and AMS 5665); Inconel 625 (AMS 5599 and AMS 5666); Hastelloy N; Hastelloy X (AMS 5536, AMS 5754, and PWA 1038); Hastelloy W Cobalt alloys: Stellite 31 (AMS 5382); Haynes 188 (AMS 5608, AMS 5772, and PWA 1042); L-605 (AMS 5537 and AMS 5759); MAR-M509 (PWA 647)
101	SOL	761	Waspaloy (nickel alloy), as AMS 5544, AMS 5706 and AMS 5707
102	SOL	762	Waspaloy (nickel alloy), as AMS 5544, AMS 5706 and AMS 5707
103	STA	763	Waspaloy (nickel alloy), as AMS 5544, AMS 5706, AMS 5707, AMS 5708 and AMS 5709
104	PRE	764	Waspaloy (nickel alloy), as AMS 5544, AMS 5706, AMS 5707, AMS 5708 and AMS 5709
105	SOL	765	Inconel 718 (nickel alloy), as AMS 5596, AMS 5662 and AMS 5663
106	SOL	766	Inconel 718 (nickel alloy), as AMS 5596, AMS 5662 and AMS 5663
107	PRE	767	Nickel alloys: Inconel 718, as AMS 5596, AMS 5662 and AMS 5663; Inconel X-750, as AMS 5598, AMS 5670 and AMS 5671

*PRE = Precipitation
SOL = Solution
STA = Stablization
STR = Stress-relief

3. CADMIUM PLATED PARTS.

a. Any part completely or partly cadmium plated scheduled to be heated above 500°F (260°C) shall first have cadmium stripped. (Refer to T.O. 2J-F100-53-1, SWP 092 05.) At temperatures above 500°F (260°C), cadmium may undergo stress alloying with underlying metal, which would be seriously detrimental to part(s).

4. COATING PRESENCE/ABSENCE BY TINT TEST ON NICKEL OR COBALT PARTS.

a. Strip coating using applicable procedure.

b. Prepare an uncoated control test piece of same material as part to be tested, by suitable cleaning, such as degreasing and blasting with grit or glass beads.

c. Heat control piece together with part to be tested, at 1075° ±25°F (579° ±14°C) for 45 to 75 minutes in air.

d. Compare colors of part and control piece. A uniform color match indicates complete coating removal.

5. PREPARATION OF TITANIUM PARTS FOR STRESS-RELIEF.

NOTE

- AMS 4901 and AMS 4921 are commercially pure titanium, and not necessarily limited to the following cleaning procedures.
- Titanium alloy parts require special cleaning before heat treatment, to prevent stress alloying by surface impurities. Disregard the thin, hard, blue-gray oxide sometimes present on titanium, which is harmless, and will not be completely removed by the following method.

a. Remove as thoroughly as possible any oil, grease, dirt, or other contaminant by wiping with a clean, lint-free cloth moistened with acetone or isopropyl alcohol.

b. Immerse parts 1 to 4 minutes maximum at 180° to 200°F (82° to 93°C) in alkaline rust remover (PS 240, SPS 2, 5, 7, 12, 25, 27 or 52). Refer to T.O. 2-1-111 for solution preparation and maintenance.

c. Pressure rinse over alkaline tank with minimal amount of cold water, then dip rinse in separate cold water tank, followed by a cold water pressure rinse.

d. Rinse in hot distilled or demineralized water at 150° to 200°F (66° to 93°C).

e. Air dry, but do not blow with compressed air.

f. Using clean white gloves for all handling, immediately after parts are dry, protect from all contamination such as dirt, dust, oil mist, fingerprints, etc. Cover with clear plastic sheet or store in a clear plastic bag until furnace or other operation is scheduled.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - HEAT TREATMENT: SOLUTION, STABILIZATION, OR PRECIPITATION CYCLES (SPOP 465, 468, 470, 480, 481, 761, 762, 763, 764, 765, 766 AND 767)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 10

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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Heat Treatment, General	WP 095 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance solution, stabilization, and precipitation heat treatment cycles. Refer to T.O. 2J-F100-53-1, WP 095 00 for general heat treatment information.

2. GENERAL.

a. The following cross-index is provided for convenience of reference.

Cycle Number	SPOP in T.O. 2-1-111	Approximate Max Temp, °F
12A	465	1350
15	468	1325
17	470	1450
20	480	2050
21	481	2150
101	761	1825
102	762	1825
103	763	1550
104	764	1400
105	765	1750
106	766	1750
107	767	1325

b. Solution heat treatment is applied particularly to Hastelloy X (nickel) parts to improve ductility and weldability prior to resizing and repair. Transition ducts (for example), made of Hastelloy X, operate for long periods at 1200° to 1700°F (649° to 927°C). Carbides, especially chromium carbides, are gradually deposited into grain boundaries under these conditions. Solution heat treatment dissolves these carbides, and returns them to metallic solution.

c. AIR COOL and AIR COOL OR FASTER mean that parts shall be cooled quickly enough to prevent metal structure changes which can happen in certain alloys if cooling is too slow. Do not liquid quench. A minimum cooling rate of 20° to 30°F (11° to 17°C) per minute to below 1000°F (538°C) is usually satisfactory. Circulating fans are permitted, but fixturing may be required in some cases to prevent distortion.

3. SOLUTION HEAT TREATMENT CYCLES.

a. These cycles apply primarily to the repair of those Hastelloy X parts which require using one of the following solution heat treatments. Specific cycle will be designated per WP/SWP.

b. Cycle 20.

CAUTION

Do not use for PWA 1038 Hastelloy X, which was specially solution treated at manufacture. Cycle 20 would destroy beneficial properties resulting from that treatment.

NOTE

Hydrogen, argon, or air are acceptable atmospheres; however, when heat treatment is to be followed by weld repair, hydrogen is preferable because of its cleaning action on oxides and impurities difficult to clean mechanically, as within cracks or cavities.

(1) Use Cycle 20 for regular Hastelloy material, unless directed otherwise per WP/SWP.

(2) Heat part to 2050° ±25°F (1121° ±14°C) and hold for 7 to 10 minutes.

(3) Air cool or faster.

c. Cycle 21.

CAUTION

Do not use for PWA 1038 Hastelloy X, which was specially solution treated at manufacture. Cycle 21 would destroy the properties resulting from that treatment.

NOTE

Hydrogen, argon, or air are acceptable atmospheres; however, when heat treatment is to be followed by weld repair, hydrogen is preferable because of its cleaning action on oxides and impurities difficult to clean mechanically, as within cracks or cavities.

(1) Use cycle 20 for regular Hastelloy material, unless directed otherwise per WP/SWP.

(2) Heat part to 2150° ±25°F (1177° ±14°C) and hold for 7 to 10 minutes.

(3) Air cool or faster.

4. SOLUTION, STABILIZATION, OR PRECIPITATION HEAT TREATMENT CYCLES.

a. These cycles apply primarily to certain age-hardenable nickel alloys such as Waspaloy and Inconel materials, for stress relief, and to dissolve precipitated carbides and intermetallics (hardeners). Specific cycle will be designated per WP/SWP.

NOTE

Parts which are susceptible to distortion during heat treatment shall be adequately supported, and temperature raised and lowered stepwise. The Suffix A following a cycle number indicates a stepwise cycle.

b. Cycle 12A.

NOTE

This is a short-term precipitation (aging) heat treatment for Inconel 718 or other part material specified by WP/SWP.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 800°F (427°C) and hold for 30 minutes.

(4) Increase to 1000°F (538°C) and hold for 30 minutes.

(5) Increase to 1200°F (649°C) and hold for 30 minutes.

(6) Increase to 1350° ±15°F (732° ±8°C) and hold for 4 hours.

(7) Cool to 1200° ±15°F (649° ±8°C) at approximately 100°F (56°C) per hour. Hold at temperature for a total of 3 hours, including cool-down time from 1350°F (732°C).

(8) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

c. Cycle 15.

NOTE

Heating and cooling rates are optional. Air is an acceptable atmosphere.

(1) Heat part to 1325° ±25°F (718° ±14°C) and hold for 4 hours.

(2) Air cool.

d. Cycle 17.

NOTE

Hydrogen, argon, or a blend of hydrogen and argon, or vacuum are acceptable atmospheres.

(1) Heat part to 1450° ±15°F (788° ±8°C) and hold for 4 hours.

(2) Cool to 500°F (260°C) at a rate equivalent to air cool.

(3) Heat part to 1325° ±15°F (178° ±8°C) and hold for 14 hours.

(4) Cool at a rate equivalent to air cool.

e. Cycle 101.

CAUTION

Heating or cooling rate between 1000°F (538°C) and 1850°F (1010°C) shall be a minimum of 40°F (22°C) per minute, to prevent cracking and to control aging characteristics.

NOTE

This is a solution heat treatment using an argon atmosphere.

(1) Place part, with thermocouples, in retort and seal retort.

NOTE

The dew point is the temperature at which moisture can condense, but in gas specifications, it is an indication of the water vapor content.

(2) Purge retort at approximately 150 cubic feet per hour (CFH) argon until dew point reaches -40°F (-40°C) or lower, at retort exhaust.

(3) Insert retort into furnace.

NOTE

Furnace may initially be set higher than 1850°F (1010°C).

(4) Heat to 1825° ±25°F (996° ±14°C), using lower thermocouple for controlling. Do not exceed 1850°F (1010°C) on higher thermocouple. Hold at temperature for two hours unless otherwise specified per WP/SWP.

(5) Remove retort from furnace and cool with forced argon to 1000°F (538°C) in 18 minutes or less.

(6) Complete cooling with argon or air.

f. Cycle 102.

CAUTION

Heating or cooling rate between 1000°F (538°C) and 1850°F (1010°C) shall be a minimum of 40°F (22°C) per minute, to prevent cracking and to control aging characteristics.

NOTE

- This is a solution heat treatment using vacuum. Heat cycle shall be completed in a range of 10 microns (mercury) pressure or lower.
- Furnace system shall provide for argon forced cooling, in order to satisfy cooling rate requirement.

(1) Place part, with thermocouples, in furnace.

(2) Evacuate to 9 microns or lower. Static leak rate shall not exceed 50 microns per hour.

NOTE

Furnace may initially be set higher than 1850°F (1010°C).

(3) Heat to 1825° ±25°F (996° ±14°C), using lower thermocouple for controlling. Do not exceed 1850°F (1010°C) on higher thermocouple. Hold at temperature for 2 hours unless otherwise specified per WP/SWP.

(4) Cool at required rate using forced argon.

g. Cycle 103.

NOTE

This is a stabilization heat treatment using air or argon.

(1) Place part in cold furnace.

(2) Heat to 1550° ±15°F (843° ±8°C) for 4 hours.

(3) Air cool.

h. Cycle 104.

NOTE

This is a precipitation heat treatment using air or argon.

(1) Place part in cold furnace.

(2) Heat to 1400° ±15°F (760° ±8°C) for 16 hours.

(3) Air cool.

i. Cycle 105.

CAUTION

Heating or cooling rate between 1000°F (538°C) and 1775°F (968°C) shall be a minimum of 40°F (22°C) per minute, to prevent cracking and to control aging characteristics.

NOTE

This is a solution heat treatment using an argon atmosphere.

(1) Place part, with thermocouples, in retort and seal retort.

(2) Purge retort at approximately 150 CFH argon until dew point reaches -40°F (-40°C) or lower, at retort exhaust.

(3) Insert retort into furnace.

NOTE

Furnace may initially be set higher than 1775°F (968°C).

(4) Heat to 1750° ±25°F (954° ±14°C), using lower thermocouple for controlling. Do not esceed 1775°F (968°C) on higher thermocouple. Hold at temperature for one hour unless otherwise specified per WP/SWP.

(5) Remove retort from furnace and cool with forced argon to 1000°F (538°C) in 16 minutes or less; then complete cooling with argon or air.

j. Cycle 106.

CAUTION

Heating or cooling rate between 1000°F (538°C) and 1775°F (968°C) shall be a minimum of 40°F (22°C) per minute, to prevent cracking and to control aging characteristics.

NOTE

- This is a solution heat treatment using vacuum. Heat cycle shall be completed in a range of 10 microns pressure or lower.
- Furnace system shall provide for argon forced cooling, in order to satisfy cooling rate requirement.

(1) Place part, with thermocouples, in furnace.

(2) Evacuate to 9 microns or lower. Static leak rate shall not exceed 50 microns per hour.

NOTE

Furnace may initially be set higher than 1775°F (968°C).

(3) Heat to 1750° ±25°F (954° ±14°C), using lower thermocouple for controlling. Do not exceed 1775°F (968°C) on higher thermocouple. Hold at temperature for one hour unless otherwise specified per WP/SWP.

(4) Cool at required rate using forced argon.

k. Cycle 107.

NOTE

This is a precipitation heat treatment using air or argon.

(1) Place part in cold furnace.

(2) Heat to 1325° ±15°F (718° ±8°C) for 8 hours.

(3) Furnace cool to 1150° ±15°F (621° ±8°C) at a rate of 100°F (56°C) or less, and hold for 8 hours.

(4) Air cool.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - HEAT TREATMENT: STRESS-RELIEF CYCLES (SPOP 455-1, 455-2, 455-3, 456, 457, 458-1, 458-2, 459-1, 459-2, 459-3, 460-1, 460-2, 461, 464, 466, 467, AND 482)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 8

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1 - 8	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Heat Treatment, General	WP 095 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance stress-relief heat treatment cycles. Refer to T.O. 2J-F100-53-1, WP 095 00 for general heat treat information.

2. GENERAL.

a. The following cross-index is provided for convenience of reference:

Cycle Number	SPOP in T.O. 2-1-111	Approximate Max Temp, °F
1	455-1	1015
1A	455-2	1015
2	456	350
3	457	900
4	458-1	1300
4A	458-2	1300
5	459-1	1600
5A	459-2	1600
6	460-1	1050
6A	460-2	1050
7	461	1500
8	455-3	1010
9	459-3	1600
11	464	1150
13	466	1400
14	467	1500
22	482	1800

b. Parts which have been repaired by fusion welding normally require stress-relief.

CAUTION

The required stress-relief (Cycle 1 or Cycle 1A) after welding or brazing Type 410 steel or Greek Ascoloy material eliminates brittleness in joint areas. To avoid cracking, parts shall be handled carefully until stress-relief has been completed.

(1) Heat treat cycle number shall be specified per WP/SWP. If experience has indicated that stress-relief is not required, it shall be so indicated per WP/SWP.

(2) If parts require a special cycle not indicated here, it shall be outlined per WP/SWP.

(3) Parts which are susceptible to distortion during heat treatment shall be adequately supported, and temperature raised and lowered stepwise. The suffix A following a cycle number indicates a stepwise cycle.

c. AIR COOL and AIR COOL OR FASTER mean that parts shall be cooled quickly enough to prevent metal structure changes which can happen in certain alloys if cooling is too slow. Do not liquid quench. A minimum cooling rate of 20° to 30°F (11° to 17°C) per minute to below 1000°F (538°C) is usually satisfactory. Circulating fans are permitted, but fixturing may be required in some cases to prevent distortion.

3. STRESS-RELIEF AFTER WELDING.

a. Cycle 1.

NOTE

Alternate Cycle 1A may be substituted to reduce distortion, or any other stepwise sequence may be used, provided stress-relief requirement of 1015° ±15°F (546° ±8°C) for 2 hours is met.

(1) Heat part to 1015° ±15°F (546° ±8°C) and hold for 2 hours.

(2) Air cool.

b. Cycle 1A.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 800°F (427°C) and hold for 30 minutes.

(4) Increase to 1015° ±15°F (546° ±8°C) and hold for 2 hours.

(5) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

c. Cycle 2.

(1) Place part in cold oven.

(2) Heat to 350° ±10°F (177° ±6°C) and hold for one hour.

(3) Air cool.

d. Cycle 3.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 900° ±15°F (482° ±8°C) and hold for 4 hours.

(4) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

e. Cycle 4.

NOTE

Alternate Cycle 4A may be substituted to reduce distortion, or any other stepwise sequence may be used, provided stress-relief requirement of 1300° ±25°F (704° ±14°C) for 2 hours is met.

(1) Heat part to 1300° ±25°F (704° ±14°C) and hold for 2 hours.

(2) Air cool.

f. Cycle 4A.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 800°F (427°C) and hold for 30 minutes.

(4) Increase to 1100°F (593°C) and hold for 30 minutes.

(5) Increase to 1300° ±25°F (704° ±14°C) and hold for 2 hours.

(6) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

g. Cycle 5.

NOTE

Alternate Cycle 5A may be substituted to reduce distortion, or any other stepwise sequence may be used, provided stress-relief requirement of 1600° ±25°F (871° ±14°C) for 2 hours is met.

(1) Heat part to 1600° ±25°F (871° ±14°C) and hold for 2 hours.

(2) Air cool.

h. Cycle 5A.

(1) Place part in cold oven.

(2) Heat to 700°F (371°C) and hold for 30 minutes.

(3) Increase to 1000°F (538°C) and hold for 30 minutes.

(4) Increase to 1300°F (704°C) and hold for 30 minutes.

(5) Increase to 1600° ±25°F (871° ±14°C) and hold for 2 hours.

(6) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

i. Cycle 6.

NOTE

Alternate Cycle 6A may be substituted to reduce distortion, or any other stepwise sequence may be used, provided stress-relief requirement of 1050° ±15°F (566° ±8°C) for 2 hours is met.

(1) Heat part to 1050° ±15°F (566° ±8°C) for 2 hours.

(2) Air cool.

j. Cycle 6A.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 800°F (427°C) and hold for 30 minutes.

(4) Increase to 1050° ±15°F (566° ±8°C) and hold for 2 hours.

(5) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

k. Cycle 7.

(1) Heat part to 1500° ±25°F (816° ±14°C) and hold for 4 hours.

(2) Air cool.

l. Cycle 8.

(1) Place part in cold oven.

(2) Heat to 600°F (316°C) and hold for 30 minutes.

(3) Increase to 800°F (427°C) and hold for 30 minutes.

(4) Increase to 1010° ±15°F (543° ±8°C) and hold for 30 minutes.

(5) Cool to 500°F (260°C) not faster than 100°F (56°C) per quarter-hour.

m. Cycle 9.

(1) Heat part to 1600° ±25°F (871° ±14°C) and hold for one hour.

(2) Air cool.

n. Cycle 11.

NOTE

Air or argon may be used except in case of titanium parts. For titanium, an inert gas only shall be used.

(1) Heat part to 1150° ±15°F (621° ±8°C) and hold for 2 hours.

(2) Air cool.

o. Cycle 13.

(1) Heat part to 1400° ±25°F (760° ±14°C) and hold for 2 hours.

(2) Air cool, or faster.

p. Cycle 14.

NOTE

Protective atmosphere is recommended.

(1) Heat part to 1500° ±25°F (816° ±14°C) and hold for 30 minutes.

(2) Furnace cool to 1100°F (593°C) at a rate of 50°F (28°C) per hour.

(3) Air cool, or faster.

q. Cycle 22.

CAUTION

Parts shall be thoroughly cleaned before entering oven.

NOTE

Hydrogen, argon, vacuum, or air are acceptable atmospheres; however, when heat treatment is to be followed by weld repair, hydrogen is preferable because of its cleaning action on oxides and impurities difficult to clean mechanically, as within cracks or cavities.

(1) Place part in cold oven; however, this step may be omitted for thin sheet metal parts.

(2) Heat part to 1800° ±25°F (982° ±14°C) and hold for 1 hour.

(3) Air cool.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLASMA AND FLAMESPRAY COATING PROCEDURES, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 26

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2 - 6	0			26 Blank	0

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Peening, Steel Shot (SPOP 501)	SWP 091 08
Chromate Conversion, Chemical, for Magnesium (SPOP 41)	SWP 092 15
Anodize Touch-up, Brush or Swab (SPOP 42)	SWP 092 16
Stripping Plasma Spray Coatings with Nitric Acid (SPOP 50)	SWP 092 18
Stripping Plasma Spray Coatings with Caustic Soda (SPOP 51)	SWP 092 19
Stripping Plasma Spray Coatings with Nickel Strip Solution (SPOP 53)	SWP 092 20
Stripping Plasma Spray Coatings with Nitric-sulfuric Acid (SPOP 304)	SWP 092 24
Flame Spray, Nickel-aluminum Wire Undercoat	SWP 096 01
Flame Spray, Nickel Aluminide Abradable Coating	SWP 096 02
Plasma and/or Flame Spray, Abradable Coatings	SWP 096 03
Plasma Spray, Polyester-aluminum Coating	SWP 096 04
Plasma Spray, High Energy	SWP 096 05

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Alcohol, denatured	O-E-760, Type III
Compound, metal-cutting (water-type)	Dasco 1773 or Mobilmet S-127 or Emulsion 51 or No. 5937
Fluid, grinding and cutting, water-type (spray mist)	X1690

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, Plasma spray	
PWA 1301 (AMS 7879)	UCAR 202 or Thermotec 18910 or Vertx VPC-01 or Haystellite 967F or Type SD-251/SD-255/ SX-182 or Metco 71VF-NS/ 71VF-NS-1 or AI-1001 or Plasmalloy 702-E or Amdry 301 or MOD KS12 or Metec or PAC 1226
PWA 1302	Plasmalloy 702-M or Compound SD 252 or UCAR 201 or Metco 71-NS or Haystellite 967 or AI-1002 or Vertx VPC-02 or PAC 125 or Amdry 302 or Metec 2020C
PWA 1305 (AMS 7875)	Haynes Alloy 730F or Metco 81VF-NS or Amdry 305/305A or AI-1005 or Plasmalloy 915-E or UCAR 204 or Vertx VPC-05 or Thermotec 18973 or Metec 2080VF
PWA 1307	Plasmalloy 915 or Metec 2080C or Metco 81-NS or Amdry 307/307A or AI-1007 or Cabot or UCAR 203 or Vertx VPC-07 or Thermotec 18970 or PAC 130 or Compound SX-172
PWA 1310	Plasmalloy 331-FP or Metco 105-NS-1 or Bendix No. 400 or UCAR 401 or AI-1010 or Thermotec 18920 or A-99
PWA 1312	Plasmalloy 327-M or Metco 201B-NS AI-1012 or PAC 801B or Thermotec 18922

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, Plasma spray (continued) PWA 1313	Plasmalloy 111-M or Metco 63-NS or Sylvania Grade 450, Compound SD 151 or Alloys 1013 or Amdry 113 or 313 or Thermotec 18851 or PAC 118-NS or Metec 3010C
PWA 1314	Amdry 314
PWA 1315	Metco 43C-NS or UCAR 607 or Haynes Alloy 2315 or Plasmalloy 207-M or Amdry 315 or AI-1015 or AI-1015-2 or Thermotec 18930 or Vertx VPC-15 or PAC 98C-1
PWA 1316	Stellite 31F or UCAR 608 or Amdry 316 or AI-1016 or Metco 45VF-NS or Vertx VPC-16 or PAC 90-VF
PWA 1317	Plasmalloy 207-F or UCAR 602 or Ancor 80 Ni-20 Cr or Amdry 317 or Metco 43F-NS or Haynes Alloy 2315 or Vertx VPC-17 or Thermotec 18923 or Metec 4050M or GTE Sylvania or AI-1017 or PAC 85F

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, Plasma spray (continued) PWA 1318	Stellite 31 or UCAR 609 or Amdry 318 or Metco 45C-NS or Vertx VPC-18 1318 or AI-1018 or Thermotec 18981 or Metec 4060
PWA 1320	Metco 54-NS or Plasmalloy 100-N or AI-1020 or Thermotec 18909
PWA 1321	Metco 404-NS
PWA 1322	Metco 439-NS
PWA 1333	Metco 210-NS or Norton 9897 or MZ80 or Zircoa 15313 or Metec 1150M
PWA 1335	Cerak-1064 or Metco 52C-NS or AI-1035 or PAC 901
PWA 1337	Metco 450-NS or Amdry 956
PWA 1338	Sylvania Compound SA 103 or Amdry 338 or Plasmalloy 11F or Thermotec 18983 or PAC 118FNS or Metec 3010 VF
PWA 1341	Metco 421 NS-1
PWA 1346	Metco 303-NS or General Plasma Associates or AI-1046 or Thermotec 18964

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, Plasma spray (continued) PWA 1347	Metco 443-NS or Amdry 960 or AI-1047 or Metec 4020C
PWA 1349	Metco 601-NS
PWA 1369	Metco 57-NS
Stick, abrasive, silicon carbide	Norton 37C400HV or Carborundum No. 349
Wheel, grinding, aluminum oxide	Norton 32A60-I8VBE
Wheel, grinding, diamond, No. 100 grit size, high (100) concentration (SD 280-N100B56 1/8)	Resinoid L Resinoid N
Wheel, grinding, silicon carbide	Jowitt & Rodgers X80J
Wheel, grinding, silicon carbide, No. 80 grit	Norton 37C80-I8V or Carborundum C80-M5V

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions and procedures for depot maintenance plasma and flame spray coatings.

2. GENERAL.

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

a. Plasma spray.

(1) Plasma sprayed coatings are applied using a high-intensity electric arc which heats an inert gas mixture to a high-velocity ionized condition called plasma. Powder used to produce the coating is injected into the heated gas stream, where it melts and is propelled to the surface to be coated.

(2) Temperature of plasma within the arc may reach 30,000°F (16,000°C); however, by the time the gas/molten powder plasma reaches the part to be coated, it has lost most of its heat. Temperature of part usually will not exceed 400°F (204°C), as plasma coating is being deposited.

b. Flame spray.

(1) Other expressions for flame spray include powder spray, wire spray, and metallizing.

(2) A gas/oxygen flame is used to melt and propel coating onto part from the gun. Gun may be mounted or handheld. Metal may be supplied either as wire or powder.

(3) Limiting temperature for flame spray (at point of melting) is approximately 5000°F (2760°C). Many coatings require the higher temperatures used with plasma spray.

(4) Flame spray coatings include nickel-aluminum wire spray, used as an undercoat, refer to T.O. 2J-F100-53-1, SWP 096 01, and various coatings used as rub strips (abradable seals). These include PWA 72, refer to T.O. 2J-F100-53-1, SWP 096 02 and PWA 74 or PWA 75, refer to T.O. 2J-F100-53-1, SWP 096 03.

c. Union Carbide Flame Plate. Do not confuse with flame spray. Flame Plate is a proprietary detonation process. Coatings include PWA 46, PWA 49, PWA 50, PWA 51, PWA 52, PWA 54 (discontinued), PWA 269, and AMS 2436.

d. Plasma coatings are often referred to as hardcoat, and should not be confused with fusion weld-type hardfacing (for this, refer to T.O. 2J-F100-53-1, SWP 093 01), or with an acid-type anodizing process also referred to as hardcoating (for this, refer to T.O. 2J-F100-53-1, SWP 092 03, AMS 2468, or MIL-A-8625, Type III). Plasma coatings are also sometimes referred to erroneously as hardface.

e. Bonding of plasma and flame spray coatings is mechanical.

f. An abradable rubstrip applied by plasma spray is PWA 255 which is a blend of aluminum and polyester. Refer to T.O. 2J-F100-53-1, SWP 096 04.

g. AMS 7879 (previously PWA 1301) may be applied by conventional plasma spray equipment (PWA 53 process), or by high energy spray equipment (PWA 253 process). For the latter process, refer to T.O. 2J-F100-53-1, SWP 096 05.

3. PLASMA SPRAY REPAIRS.

a. Plasma spray repairs are normally made last on a part. Cleaning, inspection, welding or plating repairs, and most heat treatment processes are completed before plasma spray coating is applied.

b. Instructions for stripping old coating, preparation of surface, and application and finishing of plasma coating, when required, will be provided in WP/SWP.

c. Chemical and mechanical stripping of old coating is described in paragraph 5.

d. Unless otherwise specified in WP/SWP, variation in boundaries of areas to be coated shall be minus 0.000 to plus 0.125 inch.

e. Plasma spray repairs on disks, hubs, rotor shafts, rotor spacers, and rotor airseals are not recommended except as specified per WP/SWP. When such repairs are specified, observe the following conditions:

(1) Plasma spray coating or impingement is prohibited on all snap diameter fillet radii. Such coating or impingement shall be prevented by masking prior to spraying, and not corrected by machining after spraying.

(2) Shotpeening to intensity and coverage specified per WP/SWP is required prior to grit blasting surface preparation for plasma spraying.

(3) For each snap diameter repair on a disk, hub, or rotor shaft, the fillet radius of the undercut made in preparation for the coating shall not be smaller than the original snap diameter fillet radius. Neither the undercut nor its fillet radius may extend into the adjacent face surface.

4. MASKING.

a. Usually parts should be masked before grit blasting as well as before plasma coating. This shortens time between blasting and application of coating, and reduces chance of contaminating prepared surface.

b. Areas not to be blasted and/or plasma coated may be protected with aluminum foil-backed heat-reflective tape or high temperature glass cloth tape. Masking material can be touched up after grit blasting.

c. Suitable materials for masking and/or templates include sheet metal, Teflon, silicone rubber, or other material with comparable masking properties.

5. SURFACE PREPARATION.

(See Tables 1 and 2.)

a. Degrease parts per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

b. Stripping of old coatings.

(1) Machining or grinding is most effective and positive method for removal of plasma spray, flame spray, or Flame Plate coatings from parts. Coatings which may require stripping at depot maintenance are listed in table 1. Grit blasting may also be used when specified per WP/SWP.

Table 1. Flame Plate, Plasma Spray, and Flame Spray Coatings

Coating Process	Powder Specification	Major Component (as deposited)	Coating Type
PWA 46	-	Tungsten carbide	Flame Plate
PWA 49	-	Chromium carbide	Flame Plate
PWA 50		Chromium carbide	Flame Plate
PWA 51		Tungsten carbide	Flame Plate
PWA 52		Tungsten carbide	Flame Plate
PWA 53-1 (Note 1)	AMS 7879 (was PWA 1301)	Tungsten carbide	Plasma spray
PWA 53-2	PWA 1302	Tungsten carbide	Plasma spray
PWA 53-5	AMS 7875 (was PWA 1305)	Chromium carbide	Plasma spray
PWA 53-7	PWA 1307	Chromium carbide	Plasma spray
PWA 53-10	PWA 1310	Aluminum oxide	Plasma spray
PWA 53-12	PWA 1312	Zirconium oxide (Note 2)	Plasma spray
PWA 53-13	PWA 1313	Molybdenum	Plasma spray

Table 1. Flame Plate, Plasma Spray, and Flame Spray Coatings (continued)

Coating Process	Powder Specification	Major Component (as deposited)	Coating Type
PWA 53-14	PWA 1314	Cobalt	Plasma spray
PWA 53-15	PWA 1315	Nickel	Plasma spray
PWA 53-16	PWA 1316	Cobalt	Plasma spray
PWA 53-17	PWA 1317	Nickel	Plasma spray
PWA 53-18	PWA 1318	Cobalt	Plasma spray
PWA 53-20	PWA 1320	Aluminum	Plasma spray
PWA 53-21	PWA 1321	Nickel aluminide	Plasma spray
PWA 53-22	PWA 1322	Tungsten carbide	Plasma spray
PWA 53-33	PWA 1333	Magnesium zirconate	Plasma spray
-	PWA 1334	Nickel aluminide	(Wire) Flame spray
PWA 53-35	PWA 1335	Aluminum (Note 4)	Plasma spray
PWA 53-37	PWA 1337	Nickel aluminide	Plasma spray
PWA 53-38	PWA 1338	Molybdenum	Plasma spray
PWA 53-41	PWA 1341	Magnesium zirconate	Plasma spray
PWA 53-46	PWA 1346	Magnesium zirconate	Plasma spray
PWA 53-47	PWA 1347	Nickel	Plasma spray
PWA 53-69	PWA 1369	Copper	Plasma spray
PWA 54 (Note 5)	-	Chromium carbide	Flame Plate
PWA 72	PWA 1337	Nickel aluminide	Plasma/Flame spray
PWA 74-1	PWA 1337; PWA 1352-1	Nickel aluminide Nickel	Plasma spray; Flame spray
PWA 74-2	PWA 1337; PWA 1352-2	Nickel aluminide Nickel	Plasma spray; Flame spray
PWA 75-1	PWA 1352-1	Nickel	Flame spray
PWA 75-2	PWA 1352-2	Nickel	Flame spray
PWA 253-1	PWA 1317; PWA 1346; PWA 1333	Nickel Magnesium zirconate Magnesium zirconate	Plasma spray; Plasma spray; Plasma spray

Coating Process	Powder Specification	Major Component (as deposited)	Coating Type
PWA 253-3	PWA 1337; PWA 1341; PWA 1333	Nickel aluminide Magnesium zirconate Magnesium zirconate	Plasma spray; Plasma spray; Plasma spray;
PWA 255	PWA 1337; PWA 1349	Nickel aluminide Aluminum	Plasma spray; Plasma spray
PWA 257-1	AMS 7879	Tungsten carbide	Advanced Technology Plasma spray
PWA 269	-	Copper	Flame Plate
AMS 2436	-	Aluminum oxide	Flame Platez

NOTE

(1) PWA 53 is the general process specificationf or plasma spray depostition. Suffixes are coeed to coating material composition.
(2) Used with undercoat of PWA 53-15.
(3) Used with undercoat of PWA 53-17, PWA 53-37, or PWA 1334.
(4) Used with undercoat of PWA 53-21 or PWA 53-37.
(5) Discontinued for new application.

(2) Chemical stripping may be specified per WP/SWP in order to more readily or economically strip or degrade old coatings. These methods include the following:

(a) Nitric acid solution, T.O. 2J-F100-53-1, SWP 092 18.

(b) Caustic soda solution, T.O. 2J-F100-53-1, SWP 092 19.

(c) Nickel strip solution, T.O. 2J-F100-53-1, SWP 092 20.

(d) Nitric-sulfuric acid solution, T.O. 2J-F100-53-1, SWP 092 24.

(3) Chemical stripping for various coatings on various basis alloys are listed in table 2, showing recommended stripping procedure. Procedure shown will strip or degrade the listed coatings without damage to basis alloy. For coatings not listed, or when stripping procedure is omitted in table 2, other methods are either prohibited or ineffective, and machining, grinding, or grit blasting is necessary.

Table 2. Recommended Chemical Stripping Procedures

	PWA Coating Specification/Stripping SWP			
Basis Metal Type	53-18 53-38	53-20 53-35	53-21 53-37 269	53-69 72 74 75
Stainless steel, nickel, or cobalt alloy	-	092 19	-	092 18
Low alloy steel	-	091 19	-	-
Titanium alloy	092 24	092 19	-	-
Silver or copper brazed assemblies	-	-	092 20	092 20

c. For titanium major rotating parts only, prior to grit blasting, shotpeen area to be coated to intensity of 6A plus 1, minus 0, per T.O. 2J-F100-53-1, SWP 091 08, unless otherwise specified per WP/SWP.

d. Grit blast surface conditioning.

(1) All surfaces to be coated shall be conditioned by grit blasting, preferably within 2 hours before coating, to minimize oxidation and contamination.

(2) During interval between grit blasting and coating, cover or enclose parts to protect from dust, dirt, handling, or atmospheric contamination, particularly oil vapors.

(3) Surface roughness of 200 to 300 microinches is preferred, if part configuration permits. Roughness may be reduced to as low as 63 microinches, if necessary to prevent distortion as with thin sheet metal parts.

(4) Aluminum oxide or silicon carbide, No. 24 to No. 60, are satisfactory grit selections. Aluminum oxide is somewhat preferred over silicon carbide for some materials, since aluminum oxide is not quite as hard, and does not tend as much to become embedded in surface of part. Surface contamination with grit particles would weaken coating bond strength.

(5) Inspect grit frequently for deterioration. Replace when significant fraction of fines have accumulated, or grains have become considerably rounded or polished.

(6) For titanium rotating parts to be coated with molybdenum per PWA 53-13 or PWA 53-38, use No. 320 aluminum oxide grit at 35 to 40 psi, with a nozzle angle of 45 to 90 degrees and a distance of 3 to 4 inches. This is primarily a cleaning operation. Only a slight change in texture, or dulling of surface will result. Avoid prolonged blasting which would contaminate titanium surface with embedded grit. No. 320 grit will not roughen surface, but will permit retaining greater fatigue strength without affecting the self-bonding action of the molybdenum powder.

6. SELECTION OF COATING.
(See Table 3.)

a. Engine parts shall be coated with material per repair instructions in WP/SWP. Table 3 provides general information about commonly used coatings.

Table 3. Plasma Coating Reference Chart

Coating Process (PWA)	Powder Specification	Powder Composition	Maximum Temp. °F(°C)	Recommended Thickness (mils)	Typical Application
53-1	AMS 7879 (was PWA 1301)	88% tungsten carbide and 12% cobalt (fine)	800 (427)	3 to 5 (Note 1) 2 to 6 (Note 2)	Hardcoat
53-2	PWA 1302	88% tungsten carbide and 12% cobalt (coarse)	800 (427)	3 to 6 (Note 1) 3 to 8 (Note 2)	Hardcoat
53-5	AMS 7875 (was PWA 1305)	75% chromium carbide and 25% nickel/ chromium (80/20) (fine)	1500 (816)	3 to 5 (Note 1) 2 to 6 (Note 2)	Hardcoat
53-7	PWA 1307	75% chromium carbide and 25% nickel/ chromium (80/20) (coarse)	1500 (816)	3 to 6 (Note 1) 3 to 8 (Note 2)	Hardcoat
53-10	PWA 1310	Aluminum oxide, commercially pure, white	2000 (1093)	3 to 20 3 to 10 (Note 3)	Hardcoat; Thermal barrier

Table 3. Plasma Coating Reference Chart (continued)

Coating Process (PWA)	Powder Specification	Powder Composition	Maximum Temp. °F(°C)	Recommended Thickness (mils)	Typical Application
53-12	PWA 1312	Zirconium oxide (Requires undercoat of PWA 53-15)	2000 (1093)	3 to 20 3 to 10 (Note 3)	Thermal barrier
53-13	PWA 1313	Molybdenum, commercially pure (coarse)	800 (427)	3 to 20 3 to 10 (Note 3)	Buildup
53-14	PWA 1314	Cobalt plus 28% chromium, 19.5% tungsten, 5% nickel, 1% vanadium	1600 (871)	3 to 8 (Note 2)	Hardcoat
53-15	PWA 1315	Nickel plus 20% chromium (coarse)	1500 (816)	3 to 15 3 to 10 (Note 3) 2 to 5 (Note 4)	Buildup or Undercoat
53-16	PWA 1316	Cobalt plus 25.5% chromium, 10.5% nickel, 7.5% tungsten (fine)	1800 (982)	3 to 5 (Note 1) 2 to 6 (Note 2)	Hardcoat
53-17	PWA 1317	Nickel plus 20% chromium (fine)	1500 (816)	3 to 10 3 to 5 (Note 4)	Buildup or Undercoat
53-18	PWA 1318	Cobalt plus 25.5% chromium, 10.5% nickel, 7.5% tungsten (coarse)	1800 (982)	3 to 6 (Note 1) 3 to 8 (Note 2) 3 to 20 3 to 10 (Note 3)	Hardcoat or Buildup

Table 3. Plasma Coating Reference Chart (continued)

Coating Process (PWA)	Powder Specification	Powder Composition	Maximum Temp. °F(°C)	Recommended Thickness (mils)	Typical Application
53-20	PWA 1320	Aluminum, commercially pure	500 (260)	3 to 20 3 to 10 (Note 3)	Rubstrip; buildup
53-21	PWA 1321	Nickel/ aluminum (80/20) (nickel-coated aluminum particles)	1600 (871)	3 to 15 3 to 10 (Note 3) 1 to 3 (Note 4)	Buildup or Undercoat
53-22	PWA 1322	50% tungsten carbide/ cobalt (88/12) plus 35% nickel/ chromium/ iron/silicon/ boron (70/16.5/4/4/ 3.8) plus 15% nickel/ aluminum (80/20)	800 (427)	3 to 8 (Note 2)	Hardcoat
53-33	PWA 1333	Magnesium zirconate. Requires undercoat of one of the following: PWA 1334 (See SWP 096 01 0.001 to 0.005 inch thick or PWA 53-17, 0.003 to 0.005 inch or PWA 53-37, 0.003 to 0.005 inch.	2000 (1093)	3 to 20 3 to 10 (Note 3) 6 to 10 (when top layer of PWA 253-1), 4 to 8 (when top layer of PWA 253-3)	Thermal barrier

Table 3. Plasma Coating Reference Chart (continued)

Coating Process (PWA)	Powder Specification	Powder Composition	Maximum Temp. °F(°C)	Recommended Thickness (mils)	Typical Application
53-35	PWA 1335	Aluminum/ silicon (88/12). When used on magnesium part, requires undercoat of PWA 53-21, 0.001 to 0.003 inch thick. When used on parts other than magnesium, requires undercoat of PWA 53-21 or PWA 53-37, 0.002 to 0.004 inch thick.	500 (260)	3 to 8 5 to 8 (when including undercoat)	Buildup
53-37	PWA 1337	Nickel/ aluminum (95/5) (nickel-aluminum composite particles)	1500 (816)	3 to 15 3 to 10 (Note 3) 2 to 7 (Note 4) 3 to 5 (when first layer of PWA 253-3)	Buildup or Undercoat
53-38	PWA 1338	Molybdenum, commercially pure (fine)	800 (427)	3 to 20 3 to 10 (Note 3)	Buildup
53-41	PWA 1341	65% magnesium zirconate plus 35% nickel/ aluminum (95/5)	2000 (1093)	As specified per WP/SWP.	Thermal barrier

Table 3. Plasma Coating Reference Chart (continued)

Coating Process (PWA)	Powder Specification	Powder Composition	Maximum Temp. °F(°C)	Recommended Thickness (mils)	Typical Application
53-46	PWA 1346	65% magnesium zirconate plus 35% nickel/ aluminum (80/20)	2000 (1093)	As specified per WP/SWP	Thermal barrier
53-47	PWA 1347	88% nickel/ chromium (69.5/18.5) plus 6% aluminum (nickel-chromium/ aluminum composite particles) plus binder	1500 (816)	As specified per WP/SWP	Buildup or Undercoat
53-69	PWA 1369	Copper/ nickel (62/38)	1000 (538)	As specified per WP/SWP	Rubstrip

NOTES

(1) Without grinding.

(2) Following grinding.

(3) For major rotating parts.

(4) When an undercoat.

b. The general process specification for plasma spray deposition is PWA 53. Suffixes are coded to coating material composition.

c. The process specification for certain multi-layer plasma coatings is PWA 253. Data for layers is included in tables 1 and 3.

(1) Application of PWA 253 is similar to that for PWA 53.

(2) Primary use of PWA 253 is protection from oxidation or hot corrosion, and to provide a thermal barrier for combustion chambers, afterburner parts, or other sheet metal components.

7. APPLICATION OF COATINGS.

a. It is unlikely that any two plasma guns, even from the same manufacturer, will operate exactly alike. Also, atmospheric conditions affect plasma deposition. Therefore, equipment settings are determined largely based on operator experience or trial and error, together with manufacturer’s instructions.

b. Once a satisfactory spray schedule has been determined for a particular part application, record all equipment settings, so that set-up time on similar parts can be reduced. Some of the useful data items include:

(1) Coating material.

(2) Surface preparation.

(3) Spray equipment nozzle and gases.

(4) Arc gas settings.

(5) Voltage and ampere settings.

(6) Powder feeder settings.

(7) Gun-to-work distance and angle.

(8) Preheat conditions.

(9) Cooling conditions.

c. It is necessary to check frequently during application of coating, for the need to adjust equipment settings due to drift caused by erosion of nozzle or electrode.

d. Multi-layered coating PWA 253 is applied in manner similar to that for PWA 53, using same sequence of repair operations, masking, and surface preparation outlined in paragraphs 3, 4, and 5.

(1) Layer sequence, powder identification, and thickness data are provided in tables 1 and 3.

(2) Each coating layer shall be evaluated separately unless otherwise specified per WP/SWP.

(3) Coating material shall be dry, free-flowing, and thoroughly blended.

e. Parts to be coated with PWA 53-33 shall be undercoated after grit blasting, and prior to coating application with one of the following options:

(1) PWA 1334 nickel-aluminum wire flame spray by oxyacetylene torch to thickness of 0.001 to 0.005 inch. Refer to T.O. 2J-F100-53-1, SWP 096 01.

NOTE

The specified thickness of PWA 53-33 coating shall be interpreted as a combined thickness of undercoat and the magnesium zirconate topcoat.

(2) PWA 53-17 plasma sprayed to thickness of 0.003 to 0.005 inch.

(3) PWA 53-37 plasma sprayed to thickness of 0.003 to 0.005 inch.

f. Preheat surfaces to be coated in order to remove all traces of moisture.

(1) Preheating may also be used to control thermal expansion of part with respect to coating to be applied.

(2) Preheating may be by control of torch dwell time prior to spraying, or by other suitable means.

(3) Temperature of part during preheat and subsequent spraying shall be kept low enough to prevent occurence of oxidation, distortion, discoloration, or other conditions harmful to coating or material of part.

g. When spraying aluminum or magnesium parts, take particular care not to overheat part. Maintain an average temperature below 400°F (204°C) in case of aluminum or magnesium, and a temperature below 500°F (260°C) in the case of all other part materials. Routine monitoring, however, is not required.

h. Fixturing with mechanized equipment is required, so that gun-to-work distance and spray angle remain fixed during grit blast preparation and coating process, for the following types of parts:

(1) Disks.

(2) Hubs.

(3) Blades.

(4) Rotor shafts.

(5) Rotor seals.

(6) Rotor spacers.

(7) Bearing seal plates.

i. Deposit plasma or flame spray coatings to thicknesses specified per this work package, or repair procedure in WP/SWP, or to sufficient thickness to permit finishing to dimensions specified.

j. Optional coating areas, if coated, shall be prepared, handled, and coated in same manner as required coating areas.

k. When more than one layer is to be applied, as in case of an undercoat followed by a topcoat, allow as little time between coatings as practicable, preferably less than 2 hours. Surface shall not be treated or prepared in any way between successive coatings or layers.

l. Magnesium parts whose surfaces, including edges, have been bared in preparation for spraying, or in finishing after spraying, shall have these surfaces protected per T.O. 2J-F100-53-1, SWP 092 15 prior to assembly.

m. Aluminum parts whose surfaces, including edges, have been bared in preparation for spraying, or in finishing after spraying, shall have these surfaces protected per T.O. 2J-F100-53-1, SWP 092 16 prior to assembly.

8. REMOVAL OF MASKING AND POSTCLEANING.

a. After plasma coating has been applied and part has cooled, remove all masking and clean off masking adhesive residues, using standard shop procedures and solvents.

9. FINISHING OF PLASMA COATINGS.

a. Finishing may be required, to satisfy dimensional requirements, or to reduce wear on mating parts.

b. Some coatings are harder than others, and frequent finishing by grinding is necessary.

c. Wire brushing.

(1) When finishing by wire brushing, surface roughness of coated areas to be wire brushed shall be specified per WP/SWP.

(2) Wire brushes, when used, shall have bristles of austenitic stainless steel.

(3) When polishing by wire brush is specified per WP/SWP for PWA 53-2, PWA 53-7, or PWA 53-18, coating shall be brushed or polished to a uniform appearance.

d. Grinding PWA 53-1, PWA 53-2, PWA 53-5, or PWA 53-7 coatings, using standard precision diamond grinding equipment.

(1) Use a filtered, flood-type coolant, or equivalent. A satisfactory fluid is water plus 1.0% diamond wheel grinding coolant.

CAUTION

Do not try to produce a better finish than grit size is designed to give. A dull or glazed wheel may give a shiny smooth surface, but high magnification will show a smeared surface with unacceptable heat cracks.

NOTE

- Variation in coating hardness from one coating to another will affect cutting rate. Therefore, infeeds, cross feeds, part work speed, and grinding wheel speeds may vary to obtain optimum results.
- Grooves and other irregular-shaped surfaces such as radii and spherical surfaces may be more economically finished with silicon carbide wheels such as a Jowitt and Rodgers X80J, or equivalent, which is dressed to fit the surface. This eliminates need for dressing an expensive diamond wheel.

(2) Use a resinoid bonded wheel with 100 concentration diamond grit having a hardness of L or N. Grit size may range from 100 to 400 grit depending on surface finish required.

(3) Dress and true each wheel with brake dresser to zero runout (desired) and balance on wheel balancer until there is no rotation. A separate wheel mount for each wheel will conserve labor required to remount, balance, and dress a wheel each time it is used, and will reduce loss due to dressing. Unless a diamond wheel is abused or misused, it should not require retruing unless it becomes glazed or loaded. Frequent dressing with a silicon carbide abrasive stick will keep it clean and maintain effective cutting.

(4) Finishes of approximately 20 microinches can be obtained with size No. 100 grit, approximately 10 microinches with No. 220 grit, and approximately 6 microinches with No. 400 grit when a diamond wheel is used.

(5) Use a grinding wheel speed, at periphery, of approximately 4800 to 5000 feet per minute.

(6) For internal and external grinding, infeeds on cylindrical surfaces shall not exceed a maximum of 0.0003 inch for No. 100 grit, 0.0002 inch for No. 220 grit, or 0.0001 inch for No. 400 grit for each pass. Traverse feed shall be slowest available on machine.

(7) For surface or flat grinding, down feed shall not exceed a maximum of 0.0003 inch for No. 100 grit, 0.0002 inch for No. 220 grit, or 0.0001 inch for No. 400 grit for each pass. Cross feed should range between 0.040 and 0.080 inch per pass. Traverse speed shall be determined by size of piece.

(8) When grinding, ID or OD surfaces should have a speed of 18 to 20 feet per minute (approximately 230 inches per minute) or as slow as practical in order to keep work cool, cutting action free, and to obtain a relatively smooth finish.

e. Grinding PWA 53-10 coating. The following specifications are suitable for finish grinding ID of carbon seals after application of PWA 53-10 aluminum oxide.

Wheel Speed	4800 Surface Feet per Minute (SFPM)
Work Speed	180 SFPM
Feed Rate	0.0001 inch per stroke
Traverse Rate	0.200 inch per revolution (rough) (finish)
Finish	10 microinches
Wheel Specification	No. 280 Grit Diamond with 100 concentration in resinoid bond - standard hardness
Grinding Fluid	Grinding fluid, water-type mixed at ratio of 40 parts water to 1 part base by volume. Direct mist on grinding wheel.

f. Grinding PWA 53-13, PWA 53,16, or PWA 53-18 coatings.

Wheel Speed	5500 to 6500 SFPM
Work Speed	180 to 200 SFPM
Infeed	0.0002 to 0.0003 inch, 0.0005 inch maximum per revolution of work
Traverse Speed	20 feet per minute (rough) 10 feet per minute (finish)
Wheel Specification	No. 60 Grit aluminum oxide, medium hardness, vitreous bond
Grinding Fluid	Metal-cutting Compound, (Water-type) mixed at ratio of 40 parts water to 1 part base, by volume.

g. Grinding PWA 53-21, PWA 53-35, or PWA 53-37 coatings. Normally, these coatings would be finished using conventional milling methods. However, if grinding is desired for improved part finish, the following specifications may be used:

Wheel Speed	5500 SFPM
Work Speed	180 to 200 SFPM
Infeed	0005 inch maximum per revolution of work
Traverse Speed	20 feet per minute (typical)
Wheel Specification	No. 80 Grit silicon carbide, medium hardness, vitreous bond
Grinding Fluid	Metal-cutting Compound, (Water-type), mixed at ratio of 40 parts water to 1 part base, by volume.

10. INSPECTION OF COATINGS.

a. Refer to T.O. 2-1-111 for acceptance procedures.

11. INSPECTION OF COATING AFTER GRIND OR LAPPING.

a. Examine finished surface visually.

b. Using clean, lint free, cotton cloth moistened with denatured alcohol, clean area to be examined.

(1) Remove all oil and foreign material prior to examination.

(2) Air dry.

NOTE

Do not confuse pull-outs with porosity. Porosity exceeding acceptance standards, per T.O. 2-1-111, indicates that corrective action is necessary in conditions for application of coating.

c. Using a 20X magnifier (or stronger), examine parts for clearly defined cuts and low reflectivity. Parts showing pull-outs, cracks, heat checks, or burnishing shall be re-evaluated.

d. Surface finish shall be as fine or finer than that specified for each particular part per WP/SWP.

e. Refer to T.O. 2-1-111, Chapter 19 for photographs illustrating properly ground coatings and various grinding defects.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - FLAMESPRAY, NICKEL-ALUMINUM WIRE, UNDERCOAT

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0	4 Blank	0		

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures - - - - - - - - - - - - - - - - - -	T.O. 2-1-111
Introduction and General Information - - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
WIRE, NICKEL-ALUMINUM (78/22), FLAME SPRAY	METCO 405-NS

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance nickel-aluminum wire flamespray.

2. GENERAL.

a. Wire flamespray, or metallizing, is the process of spraying molten metal onto a surface to form a coating. Wire is fed into an oxyacetylene gun flame and atomized by pressurized air into a fine spray. The part being sprayed is not heated much by this process and, therefore, distortion is kept to a minimum.

b. PWA 1334 nickel-aluminum flamespray wire may be used to produce an undercoat, especially for the plasma sprayed topcoat, PWA 53-33 magnesium zirconate. An essential feature in the use of nickel with aluminum is an exothermic reaction during deposition in which nickel aluminide is formed.

c. For quality control and acceptance standards, refer to T.O. 2-1-111.

3. PROCEDURE.

a. Sequence of repair operations, masking, and surface preparation is same as that outlined for plasma spray coatings in T.O. 2J-F100-53-1, WP 096 00.

b. Fixture part and test piece as required, and mount metallizing gun at distance of 10 to 14 inches, so that traverse will be complete with minimum waste of spray material.

c. Adjust gas pressures and flow rates per recommendations of gun manufacturer.

d. Preheat part to approximately 150° to 200°F (66° to 93°C) for 2 to 4 minutes, depending upon size of part, for moisture removal. Use metallizing torch without wire feed in operation as heat source.

e. Set timing cycle in the case of parts fixtured for a predetermined number of revolutions.

f. Start wire feed for desired cycle, interrupting as necessary for dimension checks.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - FLAMESPRAY, NICKEL ALUMINIDE ABRADABLE COATING

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, metal-cutting (water-type)	Dasco 1773 or Mobilmet S-127 or Emulsion 51 or No. 5837
Powder, plasma spray, PWA 1337	Metco 450-NS
Powder, plasma spray, PWA 1340	
(95%) PWA 1323 nickel powder	Grade DSF or Vertx VPC-23
(5%) PWA 1327 aluminum powder	Alcoa 101 powder or AI-1027
Tungsten carbide (sintered cutter)	Kennametal K68 or Valenite VC29 or Carboloy Grade 895 or Firth Sterling Grade HTA

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of nickel aluminide flamespray abradable coating.

2. GENERAL.

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

NOTE

A coating powder approximately equivalent to PWA 1337 (95/5 nickel/aluminum composite particles) is PWA 1340, made up of 94 to 96% by weight of PWA 1323 nickel powder, and 4 to 6% by weight of PWA 1327 aluminum powder. When PWA 1340 is specified, coating is designated PWA 72-1.

a. Abradable coating (PWA 72, using PWA 1337 plasma spray powder) is usually applied to airseal surfaces in three stages (phases).

(1) Inner phase is a plasma-sprayed layer of nickel-aluminum powder.

(2) Transition phase is optional. If used, it is applied using plasma and flamespray deposition of the same (nickel-aluminum) powder simultaneously.

(3) Topcoat is of same material, but applied by flamespray deposition only.

NOTE

During deposition, nickel and aluminum particles in the spray powder react together to form nickel aluminide. The properties of nickel aluminide are different from those either of nickel or aluminum.

b. Purpose of plasma spraying inner phase is to form strongest possible bond, and a dense nickel aluminide.

c. Purpose of flamespraying topcoat is to form a less dense nickel aluminide, suitable to function as a porous, abradable rubstrip.

3. PROCEDURE.

a. Sequence of repair operations, masking, and surface preparation is same as that outlined for plasma spray coatings in T.O. 2J-F100-53-1, WP 096 00.

b. Ensure that grit-glasted surfaces have a uniform matte texture without evidence of unblasted shiny sections.

c. Remove dust by blowing off part with clean, dry, filtered air, or with compressed argon.

d. Fixture part and test piece as required.

(1) If transition phase is to be applied, mount both plasma and flame guns so that spray will be coincident on part at a distance of 4 7/8 to 5 1/8 inches.

(2) Gun oscillation and fixture rotation shall provide adequate spray coverage with minimum waste.

e. Using torch without powder feed, preheat part for moisture removal to approximately 150 to 200°F (66° to 93°C) for 2 to 4 minutes, depending upon size of part.

f. Inner phase. Apply plasma spray only of PWA 1337 nickel-aluminum powder to thickness of 0.003 to 0.006 inch.

g. Clean nozzle frequently during flamespray by brushing tip with stiff wire.

h. (Optional) Transition phase. Apply both plasma and flamespray of PWA 1337 nickel-aluminum powder to an additional 0.002 to 0.004 inch.

i. Increase gun-to-part distance to 8 7/8 to 9 1/8 inches.

j. Topcoat (outer phase). Apply flamespray only of PWA 1337 nickel-aluminum powder to a total thickness that will allow machining to finish dimensions.

k. Removal, unmasking, and post-cleaning are same as that outlined in T.O. 2J-F100-53-1, WP 096 00.

4. FINISHING THE COATING.

a. When thickness is specified per WP/SWP, excess shall be removed by machining, preferably on a vertical turret lathe. The following specifications are appropriate for finishing this coating.

Machine	Vertical turret lathe with head travel maintained at maximum deviation of 0.00005 inch per inch from straight, at the boring line.
Cutting tool	Tungsten carbide (see list of Consumable Materials), 0.031 inch nose radius, 18 degree positive rake used at zero degree lead angle.
Cutting speed	990 Surface Feet per Minute.
Feed rate	0.008 inch per revolution.
Cutting fluid	Compound, metal-cutting (water-type), mixed in ratio of 40 parts water to one part compound, by volume.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLASMA OR FLAMESPRAY, ABRADABLE COATINGS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	3	19	4	0
2	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, flamespray	
PWA 1352-1 nickel/graphite (75/25)	Metco 307-NS
PWA 1352-2 nickel/graphite (85/15)	Metco 308-NE
Powder, plasma spray	
PWA 1337 nickel/aluminum (95/5)	Metco 450-NS

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of plasma and/or flamespray abradable coatings.

2. GENERAL. (See Table 1.)

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

a. Abradable coatings PWA 74 and PWA 75 are applied to airseal surfaces. Various combinations of plasma and flamespray processes are used to produce these coatings.

b. Table 1 lists the possible combinations.

3. PROCEDURE.

a. Sequence of repair operations, masking, and surface preparation is same as that outlined for plasma spray coatings in T.O. 2J-F100-53-1, WP 096 00.

Table 1. PWA 74 and PWA 75 Coatings

Abradable Coating	Undercoat (plasma-sprayed)	Topcoat * (flame-sprayed)PWA 74-1
PWA 74-1	PWA 1337 nickel/aluminum (95/5) composite particles	PWA 1352-1 nickel/graphite (75/25)
PWA 74-2	PWA 1337 nickel/aluminum (95/5) composite particles	PWA 1352-2 nickel/graphite (85/15)
PWA 75-1	(Not used)	PWA 1352-1 nickel/graphite (75/25)
PWA 75-2	(Not used)	PWA 1352-2 nickel/graphite (85/15)

*Particles are nickel-coated graphite.

b. Application of undercoat for PWA 74-1 or PWA 74-2.

(1) Fixture part and test piece as required, and mount plasma spray gun at a distance of 7 to 7 1/2 inches from work. Gun oscillation and fixture rotation shall provide adequate spray coverage with minimum waste.

(2) Using torch without powder feed, preheat part for moisture removal to approximately 150° to 200°F (66° to 93°C) for 2 to 4 minutes, depending upon size of part.

(3) Apply plasma spray undercoat of PWA 1337 nickel-aluminum composite powder to a thickness of 0.002 to 0.007 inch.

c. Application of flamespray nickel-graphite powder for PWA 74-1, PWA 74-2, PWA 75-1, or PWA 75-2.

(1) Clean flamespray nozzle frequently by brushing tip with a stiff wire.

(2) For PWA 74-1, apply PWA 1352-1 nickel/graphite (75/25) to an additional thickness of 0.040 inch, unless otherwise specified per WP/SWP.

(3) For PWA 74-2, apply PWA 1352-2 nickel/graphite (85/15) to an additional thickness of 0.040 inch, unless otherwise specified per WP/SWP.

(4) For PWA 75-1, apply PWA 1352-1 nickel/graphite (75/25) to a thickness of 0.040 inch, unless otherwise specified per WP/SWP.

(5) For PWA 75-2, apply PWA 1352-2 nickel/graphite (85/15) to a thickness of 0.040 inch, unless otherwise specified per WP/SWP.

d. Removal, unmasking, and post-cleaning are same as that outlined in T.O. 2J-F100-53-1, WP 096 00.

4. FINISHING THE PWA 74 AND PWA 75 COATINGS.

a. Coatings may be finished using conventional milling methods.

b. Thoroughly check first piece in each lot of similar parts to ensure procedure is producing desired results. Thereafter, check additional pieces as frequently as necessary to maintain control. Also, check results whenever any change in procedure is made.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLASMA SPRAY, POLYESTER - ALUMINUM COATING

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	3	19	4 Blank	0
2	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, flamespray	-
PWA 1337 nickel/aluminum (95/5)	Metco 450-NS
PWA 1349 aluminum/polyester (60/40)	Metco 601-NS

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of polyester-aluminum plasma spray coating.

2. GENERAL.

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

a. Abradable coating PWA 255 is applied to airseal surfaces in similar manner as PWA 53 plasma spray coatings.

b. Finished coating is useful at temperatures up to 650°F (343°C).

c. Coating consists of an undercoat of PWA 1337 nickel-aluminum and a topcoat of PWA 1349 polyester-aluminum. Both layers are applied by plasma spray process. PWA 1349 is approximately 60% aluminum alloy and 40% (aromatic) polyester.

d. Topcoat shall be adherent to undercoat, and to basis metal of part at coating edges. Surface shall be continuous, uniform, and free from spalling, chipping, cracking, flaking, or other objectionable imperfections.

3. PROCEDURE.

a. Coating material shall be dry, free-flowing, and thoroughly blended.

b. Sequence of repair operations, masking, and surface preparation is same as that outlined for plasma spray coatings in T.O. 2J-F100-53-1, WP 096 00.

c. Old coating of PWA 255 or other material may be removed by machining and/or grit blasting with silicon carbide abrasive. Where previous abradable coating was applied over an undercoat, it may be desirable to remove topcoat only, leaving undercoat intact as a basis for the new topcoat.

d. Apply undercoat, if required, of PWA 1337 nickel-aluminum to a thickness of 0.003 to 0.005 inch.

e. Apply topcoat of PWA 1349 polyester-aluminum to a total thickness (combined with undercoat), as specified per WP/ SWP.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLASMA SPRAY, HIGH ENERGY

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	3	19	4 Blank	0
2	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, plasma spray, AMS 7879 (previously PWA 1301)	UCAR 202 or Diamondspray 8812F or Haystellite 967F or Sylvania Type SD 251 or Metco 71 VF-NS or AI-1001 or Plasmalloy 702-E

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of high energy plasma spray coating.

2. GENERAL. (See Table 1.)

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

a. The advanced technology coating designated as PWA 257 is applied by high energy equipment, resulting in a denser and stronger deposition than PWA 53 plasma spray coatings, applied with conventional equipment.

b. Applications for PWA 257 include hard coating of engine main bearing face seals using PWA 257-1 (see table 1) as an alternative to PWA 50, or as a replacement for PWA 53-5, when specified per WP/SWP. Refer also to T.O. 2J-F100-53-1, WP 096 00.

c. Power requirement for advanced technology coating process is in the 40 to 80 kilowatt range, and the conventional plasma gun is replaced by a special model designed to operate at the higher power level.

d. Inert gas for use with PWA 257 shall be only argon or a mixture of argon with helium.

3. APPLICATION.

a. Information and illustrations relative to stripping of old coating, surface conditioning, plasma coating, and finishing of coating, where required, will be included in detailed instructions in WP/SWP.

b. Sequence of repair operations, masking, and surface preparation is same as that outlined for plasma spray coatings in T.O. 2J-F100-53-1, WP 096 00.

c. Coating shall be applied in a manner similar to that of PWA 53-1, with exceptions as noted in paragraph 2.

Table 1. High Energy Plasma Coating

Coating Process, PWA	Powder Specification	Powder Composition	Maximum Temperature, °F (°C)	Recommended Thickness, mils
257-1	AMS 7879 (was PWA 1301)	88% tungsten carbide +12% cobalt (fine)	800 (427)	3 to 5 (without grinding) 2 to 6 (following grinding)

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PLASMA SPRAY, MULTI-LAYERED

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	19	2 - 3	0	4	19

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Plasma and Flamespray Coating Procedures, General - - - -	WP 096 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Powder, plasma spray	
PWA 1317 nickel/chromium, fine (80/20)	Plasmalloy 207-F or UCAR 602 or Coast Metals 69 or Ancor 80 Ni-20 Cr or Diamondspray 8020 or Amdry 317 or Metco 43F-NS or Haynes Alloy 2315 or Vertx 1317 or HCST-1625 or Temptec 18923
PWA 1333 magnesium zirconate	Metco 210-NS or Norton 233 PR or Plasmalloy 359-E
PWA 1337 nickel/aluminum (95/5)	Metco 450-NS
PWA 1341 35% nickel/aluminum (95/5) plus 65% magnesium zirconate	Metco 421 NS-1
PWA 1346	Metco 303-NS

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of multi-layered plasma spray coatings.

2. GENERAL. (See Table 1.)

NOTE

- Depot repair facilities are required to implement a process order IAW base directive, which shall require the approval of the assign control activity, SA-ALC/LPFE.
- Contractor repair facilities are required to implement a specific quality plan IAW LPF-QPA-007. This document, which shall require the approval of the assign control activity, SA-ALC/LPFE, may be obtained from SA-ALC/LPFE, 485 Quentin Roosevelt Ave., Suite 3, Kelly Air Force Base, TX (210) 925-0792.

a. PWA 253 multi-layered plasma coatings are applied in a manner similar to that of PWA 53. Refer to T.O. 2J-F100-53-1, WP 096 00. Their primary use is to increase resistance to oxidation and hot corrosion, and to provide a thermal barrier for combustion chambers, afterburner parts, or other sheet metal components, when specified per WP/SWP.

b. Layer sequence and powder identification are denoted by a suffix following specification PWA 253. (See table 1.)

c. Each coating layer requires separate inspection and evaluation, unless otherwise specified per WP/SWP.

3. APPLICATION.

a. Sequence of repair operations, masking, and surface preparation is same as that outlined for PWA 53 coatings.

b. Instructions for application of PWA 53 coatings apply similarly to PWA 253 multi-layer coatings. Coating material shall be dry, free-flowing, and thoroughly blended.

Table 1. Multi-Layer Plasma Coatings 477

Coating Specification	Layer	Powder Specification	Composition	Max Temp °F (°C)	Recommended Thickness, mils
PWA 253-1	1	PWA 1317	80 Ni –20 Cr Alloy (Fine)	1500 (815)	3 to 5
	2	PWA 1346	35 (80 Ni +20 Cr) +65 (MgO +ZrO2)	2000 (1094)	4 to 6
	3	PWA 1333	Magnesium zirconate	2000 (1094)	6 to 10
PWA 253-3	1	PWA 1337	95 Ni –5 Al (Composite particles)	1500 (815)	3 to 5
	2	PWA 1341	35 (95 Ni +5 Al) +65 (MgO +ZrO2)	2000 (1094)	3 to 6
	3	PWA 1333	Magnesium zirconate	2000 (1094)	4 to 8

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 11	0				
12 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Coating: Process for Application of Permanent Resin ---	MIL-R-6800
Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion -------------------------------	MIL-M-3171
Introduction and General Information --------------	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3) --------------	SWP 031 01
Cleaning, Glass Bead Blast, Wet (SPOP 16) ----------	SWP 031 03
Chromate Conversion, Chemical, for Magnesium (SPOP 41)	SWP 092 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Aluminum powder, pure, atomized, No. 400	-
Aluminum wire, AMS 4180 (1100-H18)	MIL-W-6712, Type II
Cellulose nitrate (solution)	Voltax L-1423
Compound, carbon-removing	P-C-111
Enamel alkyd gloss, (gray or black)	TT-E-489
Paint remover, organic solvent-type	TT-R-251
Primer, gray Resin coating, permanent	SCM, Glidden-Durkee or Pratt & Lambert

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance painting. Also included is the PWA 44 Aluminizing procedure, Methods A, B, C, or D.

2. GENERAL.

a. Old paint not to be removed.

(1) Smooth surface with emery or crocus cloth before repainting.

(2) Thoroughly clean and dry surfaces to be painted.

(3) Plug all holes and mask all areas not to be painted.

CAUTION

If part is magnesium, treat to prevent corrosion after stripping. Refer to T.O. 2J-F100-53-1, SWP 092 15. For magnesium mating surfaces, refer to paragraphs 2.b.(4) and 2.b.(5), this WP.

b. Old paint to be removed. Follow specific removal instructions per WP/SWP. In absence of specific instructions, strip per one of following methods.

(1) Dip painted parts in heated carbon-removing compound per P-C-111.

(2) Brush painted parts with heavy coat of solvent stripper per TT-R-251. Wipe old paint from metal.

(3) Brush painted parts with stiff wire brush.

(4) For magnesium mating surfaces which contact flat gaskets, treat with chromic acid per MIL-R-3171, Type I, followed by one coat of MIL-R-3043 (permanent) resin varnish per MIL-R-6800 application procedure.

(5) For magnesium mating surfaces which do not contact flat gaskets, treat with chromic acid per MIL-R-3171, Type 1, or per T.O. 2J-F100-53-1, SWP 092 15, followed by one coat of MIL-R-3043 (permanent) resin varnish per MIL-R-6800 application procedure.

c. Inspection of various steel, aluminum, or magnesium parts coated with MIL-R-3043 preservative resin varnish coating.

CAUTION

Handle parts carefully to prevent damage to thin coating.

(1) Purpose of coating is prevention of corrosion. Appearance is shiny and transparent, with bluish or bluish-green color.

(2) Inspect resin coating for surface imperfections, spottiness, scratches, or abrasions.

(3) Magnetic particle inspection may be done on steel parts coated with resin varnish; however, intensity will be reduced and special care may be required to evaluate indications.

(4) If resin coating requires replacement, strip and recoat per MIL-R-6800.

d. This work package includes instructions for PWA 44 aluminizing by the following alternate methods:

(1) Method A - Wire flamespray.

(2) Method B - Dipping in molten aluminum.

(3) Method C - Spraying, dipping, or brushing an aluminizing paint slurry.

(4) Method D - Pack cementation.

3. APPLICATION OF PAINT.

a. Apply paint using method specified per WP/SWP. In absence of specified method, paint part as follows:

b. Dry parts thoroughly after each primer coat, using clean, dry compressed air.

c. If baking equipment is not available, paint with a type of enamel which can cure at room temperature, such as an alkyd-silicone.

(1) Spray on two coats of gray primer.

(2) Apply first coat of gray or black TT-E-489 enamel.

(3) Bake at 290° to 315°F (143° to 157°C) for 90 minutes.

(4) Apply second coat of gray or black TT-E-489 enamel.

(5) Bake at 290° to 315°F (143° to 157°C) for 90 minutes.

4. BONDING TEST IN NONCRITICAL AREA.

a. Apply good guality adhesive tape to cured, enameled surface, dry and free of contaminants.

b. Smooth out by suitable means, to obtain good adhesion.

c. Remove tape with quick motion.

d. Reprocess if any evidence of flaking or peeling.

5. PWA 44 ALUMINIZING - METHOD A.

a. Clean parts by vapor degreasing per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., or other suitable means.

b. Roughen surfaces to be coated, by blasting with abrasive or steel grit, SAE Size No. 24 to No. 100, or by acid pickling, unless otherwise specified per WP/SWP.

c. Remove dust and particles from blasted surfaces by blowing with clean, dry, compressed air.

d. Maintain blasted surfaces clean; wear clean gloves when handling parts.

e. Mask parts as required.

CAUTION

- Do not attempt to coat entire thickness in one application.
- Do not allow both spray gun and part to remain in fixed positions; either spray gun or part, or both, shall be in motion during flamespraying.

f. Metal flame spray in at least two passes, using AMS 4180 aluminum wire, or equivalent, at the following pressures, as appropriate:

(1) For city gas or propane, 30 to 33 psig.

(2) For oxygen, 32 to 34 psig.

(3) For air, 60 to 65 psig.

CAUTION

Do not use vacuum as protective atmosphere. Aluminum coating will vaporize away from part at diffusion temperature.

g. Heat in order to diffuse the aluminum coating, to a temperature and in a protective atmosphere as specified by WP/SWP.

h. Wet glass bead blast per T.O. 2J-F100-53-1, SWP 031 03 to remove excess oxide and scale from aluminized areas of parts.

i. Diffused aluminum-rich layers shall be 0.001 to 0.003 inch thick, unless otherwise specified per WP/SWP.

j. Representative completed parts, when heated for one hour at 1500°F (816°C) in air, shall show no dark oxide formation on aluminized surface.

k. Coating shall be substantially uniform in thickness and free from pinholes, scratches, cracks, crazing, and spalling.

6. PWA 44 ALUMINIZING - METHOD B.

a. Clean parts by vapor degreasig per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., or other suitable means.

b. Roughen surfaces to be coated, by blasting with abrasive or steel grit, SAE Size No. 24 to No. 100, or by acid pickling, unless otherwise specified per WP/SWP.

c. Remove dust and particles from blasted surfaces by blowing with clean, dry, compressed air.

d. Maintain blasted surfaces clean; wear clean gloves when handling parts.

e. Mask parts as required.

f. Dip in molten aluminum with a minimum purity of 99.00%.

CAUTION

Do not use vacuum as protective atmosphere. Aluminum coating will vaporize away from part at diffusion temperature.

g. Heat in order to diffuse the aluminum coating, to a temperature and in a protective atmosphere as specified by WP/SWP.

h. Wet glass bead blast per T.O. 2J-F100-53-1, SWP 031 03 to remove excess oxide and scale from aluminized areas of parts.

i. Diffused aluminum-rich layers shall be 0.001 to 0.003 inch thick, unless otherwise specified per WP/SWP.

j. Representative completed parts, when heated for one hour at 1500°F (816°C) in air, shall show no dark oxide formation on aluminized surface.

k. Coating shall be substantially uniform in thickness and free from pinholes, scratches, cracks, crazing, and spalling.

7. PWA 44 ALUMINIZING - METHOD C.

(See Table 1.)

a. Clean parts by vapor degreasing per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., or other suitable means.

b. Roughen surfaces to be coated, by blasting with abrasive or steel grit, SAE Size No. 24 to No. 100, or by acid pickling, unless otherwise specified per WP/SWP.

c. Remove dust and particles from blasted surfaces by blowing with clean, dry, compressed air.

d. Maintain blasted surfaces clean; wear clean gloves when handling parts.

e. Mask parts as required.

CAUTION

Do not attempt to paint slurry to final thickness in one application.

f. Spray, dip, or brush PS 71 aluminizing paint slurry onto part. Complete brushing process in two or more passes, using a wetted down brush. Complete spray gun process in number of passes required for depositing final thickness. Table 1 outlines the composition and preparation of PS 71 material.

CAUTION

Do not substitute vacuum for hydrogen for prediffusion heat treatment. Coating would be removed.

NOTE

This prediffusion step may be omitted if diffusion heat schedule in step 7.j. is slow enough to provide 7 to 10 minutes in the range 1150° to 1450°F (621° to 788°C).

g. Heat coated part(s) at 1335° to 1365°F (724° to 741°C) for 7 to 10 minutes in a pure, dry hydrogen atmosphere with a dew point of –40°F (–40°C) or lower, and zero detectable oxygen.

Table 1. PS 71 Aluminizing Paint Slurry

Composition		Preparation
Material	**Make-up**	
Cellulose nitrate solution	1800 to 1900 millilitres	1. Fill a suitable ball mill container with a minimum of 5 pounds of 1 inch diameter china milling balls or enough balls to fill the container 1/3 full.
Aluminum powder, atomized, No. 400	1880 to 1900 grams	2. Place a measured by weight quantity of aluminum powder into container. 3. Add a measured by volume amount of cellulose nitrate solution. 4. Mill to slurry for 2 hours at 14±4 rpm of jar.

h. Cool to room temperature, then pressure water blast to clean.

i. Check coated area for pitting or holes (eutectic melting).

CAUTION

Do not use vacuum as protective atmosphere. Aluminum coating will vaporize away from part at diffusion temperature.

j. Heat in order to diffuse the aluminum coating, to a temperature and in a protective atmosphere as specified by WP/SWP.

k. Wet glass bead blast per T.O. 2J-F100-53-1, SWP 031 03 to remove excess oxide and scale from aluminized areas of parts.

l. Diffused aluminum-rich layer shall be 0.001 to 0.003 inch thick, unless otherwise specified per WP/SWP.

m. Representative completed parts, when heated for 1 hour at 1500°F (816°C) in air, shall show no dark oxide formation on aluminized surface.

n. Coating shall be substantially uniform in thickness and free from pinholes, scratches, cracks, crazing, and spalling.

8. PWA 44 ALUMINIZING - METHOD D.

a. Clean parts by vapor degreasing per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., or other suitable means.

b. Roughen surfaces to be coated, by blasting with abrasive or steel grit, SAE Size No. 24 to No. 100, or by acid pickling, unless otherwise specified per WP/SWP.

c. Remove dust and particles from blasted surfaces by blowing with clean, dry, compressed air.

d. Maintain blasted surfaces clean; wear clean gloves when handling parts.

e. Mask parts as required.

f. Apply coating by pack cementation technique when outlined per WP/SWP.

CAUTION

Do not use vacuum as protective atmosphere. Aluminum coating will vaporize away from part at diffusion temperature.

g. Heat in order to diffuse the aluminum coating, to a temperatureand in a protective atmosphere as specified by WP/SWP.

h. Wet glass bead blast per T.O. 2J-F100-53-1 SWP 031 03 to remove excess oxide and scale from aluminized areas of parts.

i. Diffused aluminum-rich layer shall be 0.001 to 0.003 inch thick, unless otherwise specified per WP/SWP.

j. Representative completed parts, when heated for one hour at 1500°F (816°C) in air, shall show no dark oxide formation on aluminized surface.

k. Coating shall be substantially uniform in thickness and free from pinholes, scratches, cracks, crazing, and spalling.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, ALUMINUM HIGH-BAKING ENAMEL (PWA 578) (SPOP 142)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning Steel, Magnesium, or Titanium Parts, Pain and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Enamel, silicone-aluminum, high-baking (PWA 578)	DuPont Type 2, Formula 612-706 or Isis Formula LB-304 or Miller Type I or Pratt & Lambert Formula 7897
Thinner, paint	KT69

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 578 aluminum high-baking enamel.

2. STRIPPING OLD COATING.

a. Strip old enamel per T.O. 2J-F100-53-1, SWP 031 14 or T.O. 2J-F100-53-1, SWP 031 15, as appropriate.

NOTE

In certain cases,paint is specified for turbine shafts to eliminate handling scuffs on OD. Usually these areas may be retouched without stripping entire part.

b. Clean area surrounding marred regions, using emery cloth or steel wool in order to improve adhesion.

3. CLEANING.

a. Vapor degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., suspending part in vapor region approximately 0.5 minute. Spray with degreasing fluid, as required to remove soil.

b. Allow to cool.

4. APPLICATION OF ENAMEL.

CAUTION

Do not apply silicone-aluminum enamel as a protective surface treatment on any part where painted surface will be exposed to engine oil system.

a. Mask as necessary, areas not to be painted.

b. Spray or brush on first coat of PWA 578 silicone-aluminum heat-resistant enamel. Thin, if required, using KT69 thinner, or equivalent.

c. Air dry for minimum of 15 minutes. Remove masking material.

d. Raise temperature of painted part gradually. Do not place directly into preheated oven. Bake at 290° to 310°F (143° to 154°C) for 1 hour.

e. Remove from oven and cool to room temperature.

NOTE

Application of a second coat is not required on parts which have only been retouched.

f. Mask as necessary, areas not to be painted.

g. Spray or brush on a second coat of PWA 578 silicone-aluminum heat-resistant enamel, thinned, if necessary, with KT69 thinner or equivalent.

h. Air dry for minimum of 30 minutes. Remove masking materials.

NOTE

Raise temperature of painted part gradually. Do not place directly into preheated oven.

i. Bake at 290° to 310°F (143° to 154°C) for 1 hour.

CAUTION

For cadmium plated parts, omit the following bake, and continue baking for an additional 1.5 hours at 290° to 310°F (143° to 154°C). Higher baking temperature could cause stress alloying of part.

j. Bake at 490° to 510°F (254° to 266°C) for 1.5 hours.

k. Remove from oven and cool to room temperature.

l. Check for lack of complete coverage, orange peel (chipping and flaking), or other undesirable conditions.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING MAGNESIUM AND ALUMINUM PARTS WITH GRAY OR BLACK GLYCERYL PHTHALATE ENAMEL (SPOP 143)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Carbon Solvent and Paint Stripper, Two Step (SPOP 7)	SWP 031 04
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Enamel, black, AMS 3120	Voltax compound M-964-B, or equivalent
Enamel, gray, AMS 3125	Voltax compound E-1613-A, or equivalent
Primer, gray (PWA 579)	Voltax P-4525, or equivalent

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of gray or black glyceryl phthalate enamel to magnesium and aluminum parts.

2. STRIPPING OLD COATING.

NOTE

Small marred areas may require only touch-up coat of paint.

a. Strip old enamel per T.O. 2J-F100-53-1, SWP 031 04.

(1) Alternate method for aluminum parts is T.O. 2J-F100-53-1, SWP 031 14.

b. Clean up small areas with emery cloth or sandpaper to improve adhesion.

3. APPLICATION OF ENAMEL.

a. Plug holes and mask areas not to be painted.

b. Air dry between each coat.

c. Spray on two coats of PWA 579 gray primer, completely covering all bare metal.

d. Apply one coat of AMS 3125 gray enamel or AMS 3120 black enamel.

e. Bake in oven at 290° to 315°F (143° to 157°C) for 1.5 hours.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, SERMETEL W (PWA 110) (SPOP 147 AND 162)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 14

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 13	0				
14 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning, Grit Blast, Dry (SPOP 218)	SWP 031 13
Peening, Glass Bead (SPOP 500)	SWP 091 07

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	O-A-51
Alcohol, isopropyl	TT-I-735
Catalyst for SermeTel 249 touch-up	SermeTel 273
Coating, inorganic aluminum (PWA 595)	SermeTel W
Coating, aluminum, touch-up for SermeTel W	SermeTel 196
Coating, aluminum, touch-up for SermeTel W, corrosion resistant	SermeTel 249
Methyl ethyl ketone (MEK)	TT-M-261
Topcoat, high temperature finish	SermaSeal 570A

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of SermeTel W inorganic aluminum coating (PWA 110).

2. GENERAL.

(See Table 1.)

a. SermeTel W inorganic aluminum coating material is specified as PWA 595, and the process for applying it, by PWA 110.

b. There are six variations for PWA 110, depending upon curing conditions and the possible addition of a topcoat. These variations are designated PWA 110-1, PWA 110-2, PWA 110-3, PWA 110-11, PWA 110-21 and PWA 110-31. Table 1 outlines the meaning of the suffixes.

(1) If PWA 100 is specified without suffix, select appropriate procedure per table 1.

(2) When SermeTel W is applied, and cured only at 650°F, finished coated surface is not electrically conductive, and therefore does not provide galvanic protection. PWA 110-1 or PWA 110-11 may be specified, however, in case of a part which requires only a barrier-type protection.

(3) Galvanic protection can be obtained when surface is made conductive, either by burnishing or by the 1000°F bake. Burnishing means rubbing with a slightly abrasive action, but not to extent of removing any coating material. The 650°F cure followed by burnishing is usually used instead of the 1000°F cure, on parts whose material composition does not withstand higher temperature.

Table 1. Variations of SermeTel W Coating

Coating, PWA	Cure	SermaSeal 570A Topcoat
110-1	65°F bake	No
110-2	650° bake + burnish	No
110-3	650° bake + 1000°F bake	No
110-11	650°F bake	Yes
110-21	650°F + burnish	Yes
110-31	650°F bake + 1000°F bake	Yes

(4) When PWA 110-2, PWA 110-3, PWA 110-21 or PWA 110-31 is selected, the conductivity of the coated surface shall be measured with a suitable direct-reading ohmmeter or Wheatstone bridge. Place electrodes at least one inch apart, if possible, and preferably five inches or more apart. Electrodes shall not penetrate coating so as to contact basis metal.

(a) Surface electrical resistance shall be less than 30 ohms.

(b) In the case of PWA 110-21, resistance shall be measured before application of topcoat.

(c) In the case of PWA 110-31, resistance shall be measured on a test piece processed with part, receiving postcure bake (1000°F), but with topcoat omitted.

c. Preparation of coating material.

(1) SermeTel W inorganic aluminum material is supplied ready for use; no thinning is required. Keep slurry capped when not in use.

(2) Solids tend to settle out rapidly. Before opening container, mix thoroughly until all solid material is well dispersed. Agitation or mixing is also required DURING application, to maintain solid material in slurry suspension.

(3) When adequately mixed, viscosity shall be 16 to 18 seconds at 77°±0.5°F (25°±0.3°C), using a No. 2 Zahn cup.

d. Preparation of topcoat material.

WARNING

SermaSeal 570A will cause acid burns to eyes, skin, or clothing. Use adequate protection, including goggles, gloves, and apron.

NOTE

SermaSeal 570A was formerly designated SermeTel 503.

(1) SermaSeal 570A topcoat is supplied ready for use; no thinning is required. Keep material sealed when not in use.

(2) Viscosity of topcoat shall be 14.4 to 16.4 seconds at 68°±3°F (20°±1.7°C), using a No. 2 Zahn cup.

e. Equipment.

(1) DeVilbiss P-EGA-502 spray gun, at a work distance of approximately five inches and atomizing air pressure of 30 to 45 psi; or P-JGA-502 spray gun, at a work distance of 6 to 10 inches and atomizing air pressure of 45 to 60 psi, or comparable spray gun.

(2) Either standard or electrostatic spray equipment is satisfactory. Electrostatic spray is finer, and more efficient. Follow manufacturer's instructions for electrostatic spraying. Normally, a work distance of 8 to 10 inches, and atomizing air pressure of 40 psi is suitable, when using electrostatic spray.

3. APPLICATION OF COATING.

a. Stripping of previous coating.

CAUTION

Do not use stripping solutions for any other purpose. SermeTel W residues could cause solutions to become corrosive toward certain materials.

NOTE

The following stripping procedure may be used to remove SermeTel W or SermaSeal 570A from parts or assemblies of any composition, including those which contain silver braze material.

(1) Soak in SPS 2, 5, 7 or 25 alkaline rust remover at 180° to 200°F (82° to 93°C) for 30 to 90 minutes. Refer to T.O. 2-1-111 for solution preparation and maintenance.

(2) Pressure rinse with minimal amount of cold water over alkaline tank, then dip rinse in separate water tank.

(3) Pressure rinse with cold water.

(4) Rinse in hot water at 150° to 200°F (66° to 93°C).

(5) Blow dry with clean, dry, compressed air.

b. Surface preparation.

NOTE

Final preparation for coating is grit blast. Refer to T.O. 2-1-111, SPOP 218. It can also remove last traces of previous coating not completely eliminated by alkaline chemical strip.

(1) Thoroughly clean and degrease part per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(2) Mask as necessary. Plug or cover openings which are not to be coated.

CAUTION

- Surfaces shall be free from organic compounds and grit. Grit to be used for blasting shall also be free from all organic material, such as oil or grease. Do not use grit which has already been used for cleaning residues, oils, or other types of paint. Do not apply corrosion preventive oil. Prevent entrapment of grit or cleaning material in crevices.
- During and after blasting, part shall not be touched with bare hands. Wear clean gloves (polyethylene, cotton or nylon) when handling unmasked surfaces.

(3) Clean and roughen parts by wet glass bead blasting per T.O. 2J-F100-53-1, SWP 031 03 or dry aluminum oxide grit blasting per T.O. 2J-F100-53-1, SWP 031 13. For metals susceptible to rusting, as AMS 6304 (low alloy steel), dry blasting per T.O. 2J-F100-53-1, SWP 031 13 is preferred. As an alternate, any nonmetallic dry grit, size 90 to 325 mesh, may be used. Surfaces prepared by wet blasting shall be dried immediately.

(4) Blow dry with clean, dry, compressed air.

(5) Parts shall have a clean, dry matte finish, free of stains or visible residue.

c. Painting procedure - PWA 110-1.

WARNING

- SermeTel W contains very fine aluminum particles which can be a serious fire and/or explosion hazard if dried and airborne as dust, which is easily ignited or detonated. Prevent dust from forming a cloud.
- Slurry residues may also cause a secondary type of fire or explosion hazard. Aluminum metal particles coming in contact with certain acid or alkaline liquids can form hydrogen gas which is extremely flammable, and explosive. Do not allow residues to accumulate in spray booths, exhaust ducts or other equipment. If waterfall-type spray booth is used, keep water neutral by periodic testing and treating, to prevent formation of hydrogen gas.

(1) Coat part as soon as possible, but no longer than 4 hours after blasting.

NOTE

Brushing may be used in areas which cannot be coated properly by spraying.

(2) For stator assemblies only, humidity in paint spray booth shall be 60 to 80% before spraying. Stator assemblies shall remain in 60 to 80% relative humidity for at least 30 minutes after painting.

(3) For parts other than stator assemblies, humidity requirement is optional.

(4) Purge spray guns before spraying, to remove any SermeTel settlings.

(5) If more than one coating is to be applied, drying and curing shall be completed after each coat, per paragraphs 3.c.(7) through 3.c.(11).

(6) Apply SermeTel W in one or more coats to meet thickness specified per WP/SWP. Cover required area completely with thin, wet, even coat. Maintain proper spraying distance.

(7) Dry each coat in oven at 175°±25°F (79°±14°C) for 15 minutes minimum, then cool.

(8) Fish eyes (circles or partial circles of paler color) are acceptable provided such areas are not rough.

(9) Masking material shall be removed before drying and curing.

(10) Inspect coating. Any blistering, flaking, glazing, or heavy green discoloration shall be cause for rejection. In such a case, wash off unsatisfactory coating with water, and reprocess from beginning of paragraph 3.

(11) If coating is satisfactory, cure at 650°±25°F (343°±14°C) for 30 minutes minimum.

(12) Test for proper curing by rubbing a small area of part with a cotton swab soaked with water. If coating turns green, it has not cured, and shall be stripped and reapplied.

(13) nspect coating. Coating shall be adherent to basis metal, and shall have a uniform, continuous surface free from spalling, chipping, cracking, crazing, or other unacceptable flaws.

(14) PWA 110-1 does not include a 1000°F (538°C) bake, or a burnishing treatment, and therefore has no electrical resistance requirement.

d. Touch-up for isolated defects or marred spots on gaspath surfaces.

(1) Clean bared surfaces by wiping with a clean cloth moistened with TT-I-735 isopropyl alcohol.

(2) Locally apply SermeTel W as in step 3.c.(6).

(3) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(4) Cure by baking for 5 hours at 500°±25°F (260°±14°C), or for 30 minutes at 650°±25°F (343°±14°C).

e. Touch-up for isolated defects or marred spots on surfaces not in gaspath. Use same method as for gaspath surfaces (paragraph 3.d.), or use the following method:

(1) Clean all grease and oil from touch-up area with O-A-51 acetone.

NOTE

Do not reapply solvent to area after sanding. Do not touch area with bare hands.

(2) Sand area to bare metal with No. 180 grit aluminum oxide abrasive cloth.

(3) Blow dry with clean, dry, compressed air.

(4) Wipe with a clean, dry, lint-free cloth.

(5) Option A: Apply SermeTel 249 and air dry 15 to 30 minutes or until dry to touch. Spray, brush, or swab coated surface with SermeTel 273 catalyst. Allow to stand 1 hour. Wash with water, then blow dry with clean, dry, compressed air.

NOTE

SermeTel 196 does not provide galvanic (sacrificial) protection.

(6) Option B: Apply SermeTel 196 touch-up coating in two applications with either brush or spray. Air dry first coat 30 to 60 minutes. Air dry second coat 6 to 8 hours.

f. Painting procedure - PWA 110-2.

(1) Apply SermeTel W same as PWA 110-1, paragraph 3.c.

(2) Touch-up if required, per paragraphs 3.d. or 3.e.

CAUTION

Ensure that coating thickness is not reduced by burnishing operation.

(3) Burnish coated part to satisfy electrical resistance and, if required per WP/SWP, surface finish requirements. See paragraph 2.b.(4), this subordinate work package. Resistance shall be less than 30 ohms following burnishing. Burnish by one of the following methods:

(a) Light wet abrasive blasting.

(b) Light dry abrasive blasting.

(c) Glass bead peening. Refer to T.O. 2J-F100-53-1, SWP 091 07.

(d) Rubbing with Grade steel wool.

(e) Brushing with stainless steel wire brush or wheel.

(f) Light hand rubbing with fine silicon carbide abrasive impregnated nylon sheet.

(g) Other suitable method which will cause coating to become conductive.

(4) If areas have been touched up, ensure that all areas have been burnished.

g. Painting procedure - PWA 110-3.

(1) Apply SermeTel W same as PWA 110-1, paragraph 3.c.

(2) Touch-up if required, per paragraphs 3.d. or 3.e.

(3) Standard post-cure bake. Bake in oven at 1000°±25°F (538°±14°C) for 90 minutes minimum.

(4) (Alternate to standard bake). Modified post-cure bake for minimumizing distortion of certain parts such as long shafts or complex assemblies:

(a) After 650°F cure, increase heat to 800°±25°F (427°±14°C) for 30 minutes minimum.

(b) Increase heat to 1000°±25°F (538°±14°C) for 90 minutes minimum.

(c) Slow-cool at maximum of 100°F (56°C) per quarter-hour down to 500°F (260°C).

(d) Continue air cool to room temperature.

(5) Check electrical resistance per paragraph 2.b.(4). Resistance shall be less than 30 ohms.

(6) Burnish per paragraph 3.f.(3), if required for obtaining special surface finish, specified per WP/SWP.

h. Painting procedure - PWA 110-11.

(1) Apply SermeTel W same as PWA 110-1, paragraph 3.c.

(2) Touch-up if required, per paragraphs 3.d. or 3.e.

WARNING

SermaSeal 570A will cause acid burn to eyes, skin, or clothing. Use adequate protection, including goggles, gloves, and apron.

(3) Apply first coat of SermaSeal 570A topcoat over SermeTel W layer.

(4) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(5) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

NOTE

Total thickness of SermaSeal 570A topcoat is approximately 0.0001 inch, but its determination is not required.

(6) Apply second coat of SermaSeal 570A topcoat.

(7) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(8) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

i. Painting procedure - PWA 110-21.

(1) Apply SermeTel W same as PWA 110-1, paragraph 3.c.

(2) Touch-up if required, per paragraphs 3.d. or 3.e.

(3) Burnish coated part per paragraph 3.f.(3), and check electrical resistance per paragraph 2.b.(4). Resistance shall be less than 30 ohms.

(4) Clean burnished parts to remove burnishing residues. Grit particles or cleaning residues shall be completely removed from crevices.

WARNING

SermaSeal 570A will cause acid burn to eyes, skin, or clothing. Use adequate protection, including goggles, gloves, and apron.

(5) Apply first coat of SermaSeal 570A topcoat over SermeTel W layer.

(6) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(7) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

NOTE

Total thickness of SermaSeal 570A topcoat is approximately 0.0001 inch, but its determination is not required.

(8) Apply second coat of SermaSeal 570A topcoat.

(9) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(10) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

j. Painting procedure - PWA 110-31.

(1) Apply SermeTel W same as PWA 110-1, paragraph 3.c. Process a test piece along with part.

(2) Touch-up if required, per paragraphs 3.d. or 3.e.

WARNING

SermaSeal 570A will cause acid burns to eyes, skin, or clothing. Use adequate protection, including goggles, gloves, and apron.

(3) Omit application of topcoat to test piece.

(4) Apply first coat of SermaSeal 570A topcoat over SermeTel W layer on part.

(5) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(6) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

NOTE

Total thickness of SermaSeal 570A topcoat is approximately 0.0001 inch, but its determination is not required.

(7) Apply second coat of SermaSeal 570A topcoat.

(8) Dry in oven at 175°±25°F (79°±14°C) for 15 minutes minimum.

(9) Cure in oven at 650°±25°F (343°±14°C) for 30 minutes minimum.

(10) Standard post-cure bake. Bake coated part and test piece in oven at 1000°±25°F (538°±14°C) for 90 minutes minimum.

(11) (Alternate to standard bake) Modified post-cure bake for minimizing distortion of certain parts such as long shafts or complex assemblies:

(a) After 650°F cure of coated part and test piece, increase heat to 800°±25°F (427°±14°C) for 30 minutes minimum.

(b) Increase heat to 1000°±25°F (538°±14°C) for 90 minutes minimum.

(c) Slow-cool at maximum of 100°F (56°C) per quarter-hour down to 500°F (260°C).

(d) Continue air cool to room temperature.

(12) Check electrical resistance of test piece per paragraph 2.b.(4). Resistance shall be less than 30 ohms.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, ALUMINIZED EPOXY ENAMEL (PWA 568 AND PWA 569) (SPOP 148)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Curing solution for PWA 568 primer	DeSoto 910-357
Curing solution for PWA 569 enamel	DeSoto 910-465
Enamel base, PWA 569	DeSoto 529-300
Primer base, PWA 568	DeSoto 519-303
Solvent reducer for epoxy primer or enamel	DeSoto 020-324

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of aluminized epoxy enamel.

2. PROCEDURE.

NOTE

This coating was formerly referred to as Super Koropon.

a. Strip previous coating. Old epoxy enamel may be removed or softened. Refer to T.O. 2J-F100-53-1, SWP 031 15 or T.O. 2J-F100-53-1, SWP 031 14. If enamel is only softened, manual or machine brushing is necessary to complete removal.

b. Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

c. Using masking tape, mask area(s) not to be painted.

d. Prepare PWA 568 yellow epoxy primer. Mix as follows, then stir well:

(1) Primer base (519-303), 3 parts by volume.

(2) Curing solution (910-357), 1 part by volume.

(3) Solvent reducer (020-324), 2 parts by volume.

NOTE

Working life of mixed primer is approximately 8 hours at room temperature. Identify mixture as to date, and time of mixing.

e. Apply one coat of epoxy primer mixture, using standard paint air-spray gun, with filtered air. Keep equipment clean.

f. Air dry for 1 hour minimum.

NOTE

For internal surfaces, as in magnesium gearboxes, a second coat of PWA 568 primer is usually applied, and PWA 569 enamel omitted. In this case, air dry second coat 1 hour minimum. Dry film thickness of the two coats shall not exceed 0.001 inch, unless otherwise specified per WP/SWP.

g. Prepare PWA 569 aluminized epoxy enamel.

(1) Mix equal parts by volume of enamel base (529-300) and curing solution (910-465).

(2) Allow to digest (react together) for approximately 1 hour before use.

(3) After digesting, mixture may be diluted, if desired, with solvent reducer (020-324), to provide a more workable, sprayable consistency.

NOTE

Working life of enamel mixture is approximately 8 hours at room temperature. Identify mixture date, and time of mixing.

h. Apply one coat of aluminized epoxy enamel mixture, using standard paint air-spray gun, with filtered air. Keep equipment clean.

i. Bake enamel at 160° ±20°F (71° ±11°C) for 1 hour. Air drying at room temperature for a minimum of 24 hours may be substituted for the bake cycle.

j. Remove masking and check for complete coverage.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, TEFLON COATING (AMS 2515) (SPOP 149)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3) - - - - - - - - - - - - - -	SWP 031 01
Cleaning, Glass Bead Blast, Wet (SPOP 16) - - - - - - - - - -	SWP 031 03
Cleaning, Grit Blast, Dry (SPOP 218) - - - - - - - - - - - - -	SWP 031 13

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Primer for aluminum before Teflon coating	DuPont 850-202
Primer for steel or titanium before Teflon coating	DuPont 850-201
Teflon finish (AMS 2515)	DuPont 852-201

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of Teflon coating (AMS 2515).

2. PROCEDURE.

WARNING

Vaporized coating material is harmful to breathe. Provide adequate ventilation, and keep personal smoking items away from spray area. After contact with coating material, wash hands thoroughly before smoking. Ovens for fusing coating shall be vented outdoors to prevent inhaling of poisonous fumes.

NOTE

- Keep coating material refrigerated when not in use.
- Material may be sprayed as received, or thinned with distilled water up to 10% of total volume.

a. Degrease part per SWP 031 01, steps 2.a. through 2.e.

b. Cool to room temperature.

c. Use new abrasive grit for best results. Avoid using grit which has been used for other purposes.

d. Remove damaged coating or prepare surface by lightly blasting with wet glass beads, SWP 031 03 or dry aluminum oxide grit SWP 031 13.

NOTE

Do not preheat aluminum parts.

e. Preheat part at 740° to 760°F (393° to 404°C) for 15 minutes; air cool to room temperature.

CAUTION

Primer acids will corrode metal portions of spray gun if left in passages. Flush gun with clean water immediately after use.

f. Using a spray gun with stainless steel fluid passages, needle, and tip, apply primer coating 0.0002 to 0.0004 inch thick, using filtered air.

   (1) Use DuPont No. 850-201 primer for steel and titanium parts.

   (2) Use DuPont No. 850-202 primer for aluminum parts.

g. Air dry, or dry in oven at 180° to 200°F (82° to 93°C) until a dry, nonglossy appearance and medium brown color is obtained.

NOTE

When completely fused, primer coating on steel or titanium will appear blue-green; on aluminum, it will appear muddy brown.

h. Bake at 700° to 750°F (371° to 399°C) until primer coating is completely fused.

i. Cool to room temperature.

NOTE

If too heavy a final coat is applied, surface will crack when dry. If this occurs, repeat procedure from step 2.d.

j. Using a standard touch-up spray gun and filtered air, apply coating of DuPont No. 852-201 Teflon finish (AMS 2515) up to a maximum of 0.001 inch thick.

NOTE

When dry, finish coating will appear white before fusion bake.

k. Air dry, or dry in oven at 180° to 200°F (82° to 93°C) until all moisture has evaporated, and coating appears dry and nonglossy.

NOTE

When completely fused, finish coating will appear light amber, or transparent. Primer coat will remain visible through finish coat.

l. Air cool to room temperature.

m. Repeat steps 2.j. through 2.l. until coating thickness specified per WP/SWP is obtained.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, GRAPHITE VARNISH (PWA 60) (SPOP 150)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15
Cleaning, PWA 60 Graphite Varnish and PWA 474 Antigalling Compound Removal from TitaniumCompressor Blade Roots (SPOP 253, and SPOP 257)	SWP 031 17

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Graphite paste, colloidal	Dag Dispersion No. 154
Graphite Varnish, premixed	Pratt & Lambert PN 0548
Thinner, alcohol-ester solvent (AMS 3170)	-
Varnish, synthetic resin (AMS 3132)	MIL-R-3043

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of graphite varnish.

2. PROCEDURE.

CAUTION

- Graphite varnish shall not be applied to external threads, internal screw threads below the first two threads, oil holes, dowel holes, any working surfaces except gear or spline teeth or to any other surface for which graphite varnish is not required.
- Do not use dry grit blast T.O. 2J-F100-53-1, SWP 031 13 to remove old graphite varnish from compressor blade roots or disk blade slots. This type of grit blasting could cause uneven removal of part material, resulting in uneven disk loading during engine operation.

a. If old varnish requires removal, strip by one of the following methods.

(1) T.O. 2J-F100-53-1, SWP 031 14, SWP 031 15, or SWP 031 03.

(2) For titanium compressor blade roots. Refer to T.O. 2J-F100-53-1, SWP 031 17.

(3) For steel or magnesium parts, immerse in PS 101 heavy duty alkaline cleaner at 190° to 210°F (88° to 99°C) until all varnish is removed. Remove light varnish residues with a fiber brush. Rinse in agitated cold water, then in hot water at 180° to 200°F (82° to 93°C), and dry with an air blast. Refer to T.O. 2-1-111 for solution preparation and maintenance.

(4) If surface preparation is not required, none will be specified by work packages/ subordinate work packages.

b. Preparation of graphite varnish.

NOTE

Premixed graphite varnish (Pratt & Lambert PN 0548) may be used as an alternative.

(1) Mix one part by weight MIL-R-3043 synthetic resin varnish AMS 3132) with two parts by weight Dag Dispersion No. 154 graphite paste.

(2) Thin mixture with AMS 3170 alcohol-ester or any similar thinner, until consistency is suitable for application.

(3) Mixture shall contain 18 to 22% by weight of graphite.

c. Degrease per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e., if necessary.

d. Parts shall be coated by brushing or dipping to specified thickness, if spraying is not practical due to configuration.

e. Spray one or more coats of graphite varnish mixture on area of part designated per work packages/subordinate work packages, to a film thickness of approximately 0.0002 inch.

f. Air dry 10 minutes minimum between coats and after final coat.

g. Bake parts at 300° ±10°F (149° ±6°C) for 1 to 2 hours.

h. Air cool.

i. Check parts for complete coverage. Coating shall be continuous, tightly adherent, uniformly dull and black and free from bubbles, craters, pinholes, wrinkles or other surface irregularity.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, POLYURETHANE RESIN (PWA 567) (SPOP 151)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15
Anodize Touch-up, Brush or Swab (SPOP 42)	SWP 092 16

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cellosolve acetate (retarder)	-
Polyurethane Resin, clear finish (PWA 567)	Tranco 542F
Xylene	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of polyurethane resin coating (PWA 567).

2. PROCEDURE.

a. Strip previous coating. Oil polyurethane finish may be removed or softened. Refer to T.O. 2J-F100-53-1, SWP 031 15 or T.O. 2J-F100-53-1, SWP 031 14. If finish is only softened, manual or machine brushing is necessary to complete the removal.

b. Wet glass bead blast exposed metal surfaces to be coated. Refer to T.O. 2J-F100-53-1, SWP 031 03.

c. In case parts are aluminum, anodize exposed metal surfaces. Refer to T.O. 2J-F100-53-1, SWP 092 16.

d. Mask area not to be coated.

e. Polyurethane resin preparation.

NOTE

Shelf life of sealed gallons is 6 months from date of manufacture. For sealed 2 to 5 gallon containers, shelf life is 9 months from date of manufacture.

(1) Prepare thinner by thoroughly mixing equal volumes of xylene and Cellosolve acetate (retarder).

(2) Slowly add thinner mixture to polyurethane resin, stirring thoroughly, until reduced to spraying consistency.

f. Apply two coats of thinned resin to parts.

NOTE

Total dried film thickness (two coats) shall be 0.001 to 0.002 inch.

g. Air dry 20 to 30 minutes between coats.

h. Remove masking.

i. Parts may be placed directly in preheated oven.

j. Bake parts at 220° ±25°F (104° ±14°C) for 30 to 60 minutes. Cool to room temperature.

k. Check parts for complete coverage. Coating film shall be hard, tough, smooth, and free from defects such as checking, wrinkling, dulling, streaking, blistering, or other surface irregularity, and free from noticeable discoloration.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, SYNTHETIC RESIN VARNISH (PWA 3132) (SPOP 152)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Tetrachloroethylene (Perchlorethylene)	O-T-236
Thinner, alchohol-ester solvent (AMS 3170)	-
Varnish, synthetic resin (AMS 3132)	MIL-R-3043

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of AMS 3132 synthetic resin varnish.

2. TOUCH-UP PROCEDURE.

NOTE

For reapplication procedure, see Paragraph 3.

a. Preparation of varnish. Thoroughly mix AMS 3132 resin. Viscosity shall be approximately 36 seconds, measured with a No. 1 Zahn cup. If necessary, thin with AMS 3170 alcohol-ester until correct viscosity is obtained.

b. Remove damaged varnish using a No. 320 emery cloth.

c. Clean off emery residue with soft rag.

d. Wipe area to be varnished, using a clean cloth moistened with O-T-236 tetrachloroethylene (perchlorethylene).

e. Wipe off any solvent with a clean, dry cloth.

NOTE

Preferred thickness of dried varnish on flat, smooth surfaces is 0.00025 inch.

f. Paint area to be touched up with AMS 3132 varnish resin, using a fine bristle brush or a spray gun, to obtain a coating 0.00015 to 0.00025 inch thick.

g. Allow to air dry 15 minutes before handling.

3. REAPPLICATION PROCEDURE.

a. Ensure that part has been processed through routine depot maintenance cleaning.

b. Mask all areas not requiring varnish.

c. Strip previous coating per T.O. 2J-F100-53-1, SWP 031 14 or T.O. 2J-F100-53-1, SWP 031 15, as appropriate.

d. Preparation of varnish. Thoroughly mix AMS 3132 resin. Viscosity shall be approximately 36 seconds, measured with a No. 1 Zahn cup. If necessary, thin with AMS 3170 alcohol-ester until correct viscosity is obtained.

NOTE

- Preferred thickness of dried varnish on flat, smooth surfaces is 0.00025 inch.
- Thickness of dried varnish on shotpeened, sandblasted, and nonmachined surfaces shall not exceed 0.0001 inch.

e. Apply AMS 3132 varnish resin at room temperature, using a fine bristle brush or a spray gun, until part is uniformly coated to a thickness of 0.00015 to 0.00035 inch.

f. Dry part in still air at room temperature for 2 to 5 minutes.

g. Check coating for bare spots, uniformity and hue of color, smoothness, and blemishes. Traces of orange peel (slight crazing) are acceptable.

h. Bake in a drying oven at 300° ±10°F (149° ±6°C) for 40 to 150 minutes. Color of finish will become light to greenish-blue.

i. Air cool to room temperature.

j. Remove all masks and clean up any varnish which may have seeped under masks.

k. Preserve steel parts in corrosion preventive compound as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, GREEN CERAMIC FINISH (PWA 599) (SPOP 154)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3) - - - - - - - - - - - - - - -	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Green ceramic slurry	Solaramic S5-8A
Grit, aluminum oxide, No. 150	Blastite BT No. 150 or Arrow Blast No. 150
Grit, zirconium silicate, No. 120	Zirconite No. 120
Tape, masking plastic	Scotch No. 484 or Prata PV-165B

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 599 green ceramic finish.

2. PROCEDURE

a. Degrease part per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

b. Cool to room temperature.

c. Remove damaged coating or prepare surface by dry abrasive blasting using No. 150 aluminum oxide abrasive grit, or No. 120 zirconium silicate grit at 40 psig minimum.

d. Mask areas not to be coated, using sufficient layers of plastic masking tape, or equivalent, or mechanical masks.

NOTE

If slurry does not completely pass through No. 60 mesh seive, pass through a ball mill or agitate for at least an additional hour, then strain again.

e. Agitate green ceramic slurry by shaking, stirring, or otherwise mixing, until all solids are uniformly suspended, and strain through a No. 60 mesh sieve.

f. Apply one coat of green ceramic slurry by either standard or electrostatic paint spray equipment to a film with dried thickness of 0.0010 to 0.0020 inch, unless otherwise specified per WP/SWP.

g. Air dry coating for 20 to 30 minutes.

h. Cure coating at 1000° ±25°F (538° ±14°C) for 30 minutes minimum, then cool.

i. Check for satisfactory coverage.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, ZINC CHROMATE PRIMER (PWA 3110) (SPOP 157)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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4 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, corrosion preventive	AMS 3065 or MIL-C-15074
Primer, zinc chromate (AMS 3110)	TT-P-1757
Thinner, fast-drying	KT46 Thinner
Thinner, slow-drying	V-144 Reducer

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of AMS 3110 zinc chromate primer.

2. PROCEDURE.

a. Thoroughly mix AMS 3110 zinc chromate primer. Viscosity shall be approximately 24 seconds, measured with a No. 1 Zahn cup. If necessary, thin with either KT46 fast-drying thinner or V-144 slow-drying reducer, until correct viscosity is obtained.

b. Strip previous coating per T.O. 2J-F100-53-1, SWP 031 14 or SWP 031 15, as appropriate.

c. Air dry; cool to room temperature.

d. Mask as necessary.

e. Air dry to touch between coats.

f. Apply one or two coats of AMS 3110 zinc chromate primer by dipping, brushing or spraying.

g. Remove all masking materials.

h. Bake in oven at 300° ±10°F (149° ±6°C) for 1 hour minimum; cool to room temperature.

i. Inspect for complete coverage.

j. Preserve any exposed steel parts with corrosion preventive compound, as required.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, TOUCH-UP, TURBINE BLADES OR VANES COATED WITH COBALT ALLOY COATINGS PWA 33, PWA 68, OR PWA 268, OR ALUMINIDE COATINGS PWA 45, PWA 73, OR PWA 273, USING COBALT-ALUMINUM SLURRY (PWA 545) (SPOP 158)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

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REFERENCE MATERIAL REQUIRED

Title		Number
Introduction and General Information	- - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning Vapor, Degreaser (SPOP 3)	- - - - - - - - - - - - - - -	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone	-
Cobalt-aluminum touch-up slurry (PWA 545)	O-A-51
Grit, aluminum oxide, No. 240	Pratt & Whitney PN SR741613
Tape, masking, high temperature	Scotch High Temp No. 213 or Tuck Hi-Temp. No. 134 or Permacel No. 703 or Arno No. C-673 or No. C-675 or Mystick No. 6250 or Bear No. 102 or PG-8

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance touch-up painting of turbine blades or vanes coated with cobalt alloy coatings PWA 33, PWA 68 or PWA 268, or aluminide coatings PWA 45, PWA 73 or PWA 273, using PWA 545 cobalt-aluminum slurry.

2. PROCEDURE.

WARNING

- PWA 545 cobalt-aluminum slurry contains very fine cobalt and aluminum particles which can be a serious fire or explosion hazard if dried and airborne as a dust, which is easily ignited or detonated. Prevent dust from forming a cloud.
- Slurry residues may also cause a secondary type of fire or explosion hazard. Cobalt or aluminum metal particles coming in contact with certain acid or alkaline liquids can form hydrogen gas, which is extremely flammable, and explosive. Do not allow residues to accumulate in spray booths, exhaust ducts, or other equipment. If waterfall-type spray booth is used, keep water neutral by periodic testing and treating, to prevent formation of hydrogen gas.

a. Keep slurry tightly sealed in original container in a cool location when not in use. Shelf life is unlimited, although settling will occur.

b. Material preparation. Stir or shake in original container, to break up lumps and suspend powder, until all solids are uniformly dispersed.

c. Surface preparation.

(1) Degrease part per T.O. 2J-F100-53-1, SWP 031 01, steps 2.a. through 2.e.

(2) Mask areas not to be painted, using high temperature masking tape.

CAUTION

Gloves shall be worn when handling surfaces following cleaning and prior to application of coating.

(3) Grit blast area to be painted using No. 240 aluminum oxide grit at 30 psig (suction-type cabinet) or 20 psig (pressure-type cabinet) to remove scale and oxides.

(4) Remove masking.

(5) Power flush (water blast) until rinsed clean. Ensure removal of all blasting grit and masking tape residue.

(6) Rinse all surfaces with acetone, then air dry.

(7) Remask areas not to be painted, allowing for an overspray of 0.010 to 0.100 inch.

(8) Weigh part to nearest milligram if coating thickness requirement is to be determined by weight. See paragraph 2.d.(6).

d. Application.

NOTE

- A Binks Model 62 spray gun with Minimix stirrer, or comparable equipment, is suitable.
- Solids tend to settle out rapidly. Agitation or mixing is necessary during application to ensure that solids do not settle out.

(1) Purge spray gun before spraying, to clear all passages and lines of oil slurry solids.

(2) Apply PWA 545 cobalt-aluminum (touch-up) slurry by brushing or spraying, as uniformly as possible. If spray method is used, apply relatively dry at a work distance of 18 to 20 inches, with an atomizing air pressure of 30 to 32 psi.

(3) Overlap of touch-up with existing coating shall be continuous and evenly faired.

(4) Dry at 300° ±10°F (149° ±6°C) for not less than 15 minutes.

CAUTION

Do not handle coated surfaces until after diffusion heat treatment. See paragraph 2.e.

(5) Cool to room temperature.

(6) Weigh part to determine amount of slurry applied, or measure thickness of coating touch-up. Required quantity is 0.030 to 0.040 grams per square centimeter, or a thickness of 0.010 to 0.015 inch. Obtaining required thickness usually takes two or three coating applications.

(7) Repeat as necessary until coating is adequate, beginning with step 2.d.(2).

(8) Remove masking tape and inspect green slurry coatings for cracks, spalling, or lifting. If indications of any of these conditions appear, scrub off green slurry with a stiff brush and water, and repeat entire procedure, begining with paragraph 2.c.

e. Diffusion heat treatment.

NOTE

Diffusion heat treatment shall be done as soon as possible after slurry application, but not later than 8 hours after application.

(1) Load parts into rack, then into furnace very carefully, so as not to damage slurry coating.

NOTE

An acceptable alternative to hydrogen is high purity argon gas, with a dew point of less than –40°F (–40°C).

(2) Heat treat coated parts for four hours in a furnace at 1975° ±25°F (1079° ±14°C) with an atmosphere of hydrogen, having a dew point less than –40°F (–40°C).

(3) Cool parts to 600°F (316°C) in protective atmoshere at a rate equivalent to air cooling (approximately 35°F (19°C) per minute, or faster).

(4) After cooling to 600°F (316°C), parts may be removed from furnace for completion of cooling.

(5) Clean off powdery residue and oxide film by grit blasting, using No. 240 grit aluminum oxide abrasive at 30 psig (suction-type cabinet) or 20 psig (pressure-type cabinet).

(6) Precipitation heat treat, and shotpeen to required intensity as specified per WP/SWP.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - PAINTING, TOUCH-UP, TURBINE BLADES OR VANES COATED WITH PWA 47 OR PWA 73, USING SERMETEL J ALUMINUM-SILICON SLURRY (PWA 596) (SPOP 159)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	0				
6 Blank	0				

REFERENCE MATERIAL REQUIRED

Title		Number
Introduction and General Information	- - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning Vapor, Degreaser (SPOP 3)	- - - - - - - - - - - - - - -	SWP 031 01

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone (b O-A-51	-
Aluminum-silicon touch-up slurry (PWA 596)	SermeTel J
Grit, aluminum oxide, No. 240	-
Tape, masking, high temperature	Scotch High Temp.- No. 213 or Tuck Hi-Temp.No. 134 or Permacel No. 703 or Arno No.C-673 or No.C-675 or Mystik No. 6250 or Bear No. 102 or PG-8

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance touch-up painting of turbine blades or vanes coated with aluminum-silicon coating (PWA 47 or PWA 73), using SermeTel J aluminum-silicon slurry (PWA 596).

2. PROCEDURE.

WARNING

- PWA 596 aluminum-silicon slurry contains very fine aluminum particles which can be a serious fire and/or explosion hazard if dried and airborne as a dust, which is easily ignited or detonated. Prevent dust from forming a cloud.
- Slurry residues may also cause a secondary type of fire or explosion hazard. Aluminum metal particles coming in contact with certain acid or alkaline liquids can form hydrogen gas, which is extremely flammable or explosive. Do not allow residues to accumulate in spray booths, exhaust ducts or other equipment. If waterfall-type spray booth is used, keep water neutral by periodic testing and treating, to prevent formation of hydrogen gas.

a. Keep slurry tightly sealed in original container in a cool location when not in use. Shelf life is unlimited, although settling will occur.

b. Material preparation.

(1) Stir or shake in original container, to break up lumps and suspend powder, until all solids are uniformly dispersed.

(2) If small lumps persist after shaking, continue to shake in original container by an ultrasonic method.

c. Surface preparation.

(1) Degrease part per T.O. 2J-F100-53-1, SWP 031 01, step 2.a. through 2.e.

(2) Mask areas not to be painted, using high temperature masking tape.

CAUTION

Gloves shall be worn when handling surfaces following cleaning and prior to application of coating.

(3) Grit blast area to be painted using No. 240 aluminum oxide grit at 30 psig (suction-type cabinet), or 20 psig (pressure-type cabinet), to remove scale and oxides.

(4) Remove masking.

(5) Power flush (water blast) until rinsed clean. Ensure removal of all blasting grit and masking tape residue.

(6) Rinse all surfaces with acetone, then air dry.

(7) Remask areas not to be painted, allowing for an overspray of 0.010 to 0.100 inch.

d. Application.

(1) Brush SermeTel J aluminum-silicon slurry onto area to be touched up. Agitate slurry container frequently to ensure solids do not settle out.

(2) Cure under heat lamps or in electric oven at 175° ±25°F (79° ±14°C) for 15 minutes.

CAUTION

Do not handle coated surfaces until after diffusion heat treatment. See paragraph 2.e.

(3) Air cool to room temperature.

(4) Repeat steps 2.d.(1) through 2.d.(3) two more times, for a total required coating thickness of 0.005 to 0.007 inch.

(5) Remove masking tape and inspect green slurry coating for cracks, spalling or lifting. If indications of any of these conditions appear, scrub off green slurry with a stiff brush and water, and repeat entire procedure, beginning with paragraph 2.c.

e. Diffusion heat treatment.

NOTE

Diffusion heat treatment shall be done as soon as possible after slurry application, but not later than 8 hours after application.

(1) Load parts into rack, then into furnace very carefully, so as not to damage slurry coating.

NOTE

An acceptable alternative to hydrogen is high purity argon gas, with a dew point of less than –40°F (–40°C).

(2) Heat treat coated parts for 15 to 30 minutes in a furnace at 1600° ±25°F (871° ±14°C) with an atmosphere of hydrogen, having a dew point less than –40°F (–40±C).

(3) Increase heat to 1975° ±25°F (1079° ±14°C) for 4 hours.

(4) Cool parts to 600°F (316°C) in protective atmosphere at a rate equivalent to air cooling (approximately 35°F (19°C) per minute, or faster).

(5) After cooling to 600°F (316°C), parts may be removed from furnace for completion of cooling.

(6) Clean off powdery residue and oxide film by grit blasting, using No. 240 grit aluminum oxide abrasive at 30 psi (suction-type cabinet) or 20 psi (pressure-type cabinet).

(7) Precipitation heat treat, and shotpeen to required intensity as specified per WP/SWP.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUNDS, APPLICATION, GENERAL

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 10

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4 - 6	0				
7	19				
8 - 9	0				
10 Blank	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Practices Manual -	T.O. 2-1-111

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
COMPOUND, ANTIGALLING (PWA 36545)	ESNALUBE 382
COMPOUND, ANTIGALLING AND ANTISEIZING	PARKER THREAD LUBE
COMPOUND, ANTISEIZE (PWA 36001)	SILVER GOOP
COMPOUND, JOINTING (SEALING) PWA 36000-3, MEDIUM GRADE PWA 36000-4, LIGHT GRADE	HYLOMAR PL-32
COMPOUND, LUBRICATING, ANTISCUFFING AND ANTISEIZING	MOLYKOTE G-N
COMPOUND, SEALING	PERMATEX FORM-A-GASKET NO. 2 OR PERMATEX AVIATION FORM-A-GASKET NO. 3 OR PARKER SEALUBE OR DOW CORNING NO. 4
GREASE, EXTREME PRESSURE	LUBRIPLATE 1200-2
GREASE, GRAPHITE	GREDAG NO. R-4
GREASE, HIGH TEMPERATURE	PLASTILUBE NO. 3 OR PLASTILUBE MOLY NO. 3
LUBRICANT, DRY FILM (PWA 36035)	FEL-PRO C-300
LUBRICANT, DRY FILM GRAPHITE	DGF-123
LUBRICANT, GAGE PENETRATING OIL)	MARVEL MYSTERY OIL
MOLYBDENUM DISULFIDE, POWDER	MIL-M-7866
OIL, LUBRICATING	MIL-L-6081, GRADE 1010

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains general instructions for depot maintenance application of compounds.

2. GENERAL.

CAUTION

- Ensure that antigalling and antiseizing compounds are applied in thin, even coats, and that all excess material is completely removed. Excess compound getting into or onto certain parts, passages, or surfaces could cause malfunction or even failure of an engine.
- Sealing compounds, shall not be used in place of properly finished parts, good assembly practices, or dimensional accuracy.

a. Antigalling or antiseizing compounds are prohibited at the following locations:

(1) Fuel fittings.

(2) Face splines.

(3) Conical seats.

(4) Main rotor disk, hub, and spacer snaps.

b. Sealing compounds are prohibited at the following locations.

(1) All connections in engine fuel system.

(2) All splined assemblies.

(3) All metallic oil seal rings and oil ring carrier grooves.

(4) Any parts which have relative motion to each other during engine operation.

c. Compounds refer to the following classes of materials. A brief definition is included with each term, and the common trade designation for compound(s) of the type described. Some terms are either partly or completely interchangeable. Some compounds meet the description under more than one of the terms. Cross-references to subordinate work packages are also provided.

(1) Anaerobic adhesive - an adhesive cement (retaining compound) which depends upon ABSENCE of air in order to set up (solidify) and harden. Loctite No. 40 (PWA 549, Type II): per T.O. 2J-F100-53-1, SWP 098 06.

(2) Antigallant - prevents transfer of metal from one surface to another caused by severe chafing action. Also prevents seizing (freezing-up of threads or joints), and may provide some corrosion protection.

(a) PWA 36035 (Fel-Pro C-300).

(b) PWA 559 (Fel-Pro C-652). Refer to SWP 098 05.

(c) Parker Thread Lube.

(d) PWA 550 (Sandstrom Hi-T 650 or Lubri-Bond HT or Molykote 1-3943). Refer to SWP 098 03.

(e) PWA 474 (LS 2065). Refer to T.O. 2J-F100-53-1, SWP 098 04.

(f) PWA 36545 (Everlube 382). Refer to T.O. 2J-F100-53-1, SWP 098 07.

(3) Antiscuffing compound - a grease for prevention of shallow, superficial abrasions. (Those which cannot be felt with an inspector’s scriber.) PWA 587 (Molykote G-n).

(4) Antiseizing compound - prevention of seizing (freezing up) of threads or joints at assembly; making disassembly easier for certain hot section and afterburner theaded fittings. May also be an antigallant, but not necessarily.

(a) PWA 541 molybdenum disulfide lubricant. Refer to paragraph 4. b.

(b) Silver Goop.

(5) Grease, extreme pressure - lubricant for heavily loaded or highly stressed parts, such as splines, snaps, journals, etc, to prevent galling. Lubriplate 1200-2.

(6) Grease, graphite - assembly lubricant for ball and socket joints, and snugly-fitting parts such as bearing races, spacers, and seals on hubs and shafts. Gredag R-4 graphite grease.

(7) Grease, high temperature - bentonite-type spline grease for use in locations external to engine.

(a) Plastilube No. 3.

(b) Plastilube Moly No. 3.

(8) Jointing compound - a sealing compound for threaded fittings or metal-to-metal mating surfaces. Hylomar PL-32 (PWA 36000-3, medium; PWA 36000-4, light).

(9) Lubricant, dry film - see lubricant, solid film.

(10) Lubricant, gage - see penetrating oil.

(11) Lubricant, solid film - a thin layer of very fine particles which reduce friction, such as graphite or molybdenum disulfide, disposited usually by propellant spray, or brushed onto part, followed by complete or partial evaporation of the carrier or vehicle.

(a) Dgf-123 colloidal graphite dry film lubricant.

(b) PWA 585 (Molykote X-15) per T.O. 2J-F100-53-1, SWP 098 02.

(12) Lubricant, thread - antigalling or antiseizing compound especially intended for threads.

(13) Penetrating oil - special lubricant to aid disassemby. Marvel Mystery Oil gage lubricant.

(14) Retaining compound - adhesive cement such as anaerobic adhesive compound. (See anaerobic adhesive.)

(15) Sealant, gasket - compound which can be molded into gasket shape, and then forms a semisolid seal similar to a preformed gasket.

(a) Permatex Form-A-Gasket No. 2.

(b) Permatex Aviation Form-A-Gasket No. 3.

(c) Parker Sealube.

(16) Sealing compound - gas/liquid barrier to ensure against slight seeping; sometimes used on surface of a gasket to reduce sticking to mating surfaces. Sometimes called a jointing compound. (See jointing compound.) Dow Corning No. 4.

3. ANTIGALLING COMPOUNDS AND LUBRICANTS.

a. Fel-Pro C-300.

CAUTION

Do not use Fel-Pro C-300 on parts that have been coated with PWA 36545 antigalling compound, torque values could be affected.

(1) Wet applications of Fel-Pro C-300 dry film lubricant (PWA 36035) without prior surface preparation or post-baking are permissible for threaded parts and mating faces of threaded and other parts in combustion and augmentor sections. Normally, drying at room temperature requires 0.5 to 1.0 hour. Parts will dry faster when warm, and slower when cold.

CAUTION

To avoid incorrect application of SPOP 146, do not substitute wet Fel-Pro C-300 indiscriminately where SPOP 146 is specified.

(2) Fel-Pro C-300 (PWA 36035) may be cured by baking per cycle in SPOP 146. Refer to T.O. 2-1-111.

b. Graphite dry film lubricant dgf-123 has been found satisfactory for use on ball sockets and in assembly of bearing races, spacers, and seals on hubs and shafts.

c. Gredag R-4 graphite grease and Lubriplate 1200-2 extreme pressure grease may be used on gasket surfaces to reduce sticking, or to ensure against slight seeping. Lubriplate 1200-2 is also satisfactory for use on all interference fit splines.

d. Plastilube No. 3 and Plastilube Moly No. 3 bentonite-type high temperature greases have been found satisfactory for use on accessory spline drives with a loose fit and external to the engine without other means of lubrication.

e. Parker Thread Lube antigalling and antiseizing compound is approved for spark igniter plug threads, studs, and steel threaded case assembly plugs.

f. Marvel Mystery Oil gage lubricant is approved for aiding disassembly of engines and afterburners as a penetrating oil.

4. MOLYBDENUM DISULFIDE-TYPE COMPOUNDS.

CAUTION

Compound containing molybdenum disulfide shall not be used on studs in aluminum or magnesium cases.

a. Molybdenum disulfide, either in powder form (MIL-M-7866), or suspended in oil or alcohol, is satisfactory for use in assembling combustion chamber cases, turbine nozzle cases, exhaust cases, and turbine shaft splines or threads.

b. PWA 541 antiseizing compound lubricant.

(1) Thoroughly mix molybdenum disulfide powder with Grade 1010 oil in the following proportion:

MIL-M-7866 powder 77 to 83% by weight

MIL-L-6081, Grade 1010 oil 17 to 23% by weight.

(2) Continue mixing until lubricant is smooth, and free from lumps, cakes, skins, and grit.

(3) Store in closed containers to avoid contamination.

c. PWA 550 antigalling compound is approved for reducing galling and wear as on titanium blade roots, and on nickel alloy socket seats, at temperatures up to 800°F (427°C). It contains molybdenum disulfide, antimony trioxide, and a silicone resin binder, in a xylene carrier. Refer to SWP 098 04.

d. PWA 474 antigalling compound is approved for reducing galling and wear on steel and titanium parts. Refer to SWP 098 04.

e. PWA 585 solid film lubricant is approved for reducing galling and wear on mating parts where contact with fuel or oil may be encountered. Refer to SWP 098 02.

f. PWA 36545 antigalling compound is approved for reducing galling and wear on titanium, nickel, and steel parts where a compound not containing lead is preferred. PWA 36545 contains only molybdenum disulfide in a vehicle-dispersed binder. Refer to T.O. 2J-F100-13-1, SWP 098 07.

5. SEALING COMPOUNDS.

a. General.

(1) Certain sealing compounds are authorized in order to provide additional assurance against minor leaks, on some threaded parts, metal-to-metal seals, and gasketed mating surfaces.

(2) Mating surfaces to which sealing compound is to be applied shall be completely free of all foreign materials such as oil, grease, or gasket materials.

(3) Sealing compound shall be applied in a very thin layer on both mating surfaces. Excess compound forced out of contact area during assembly shall be carefully removed.

b. Materials.

A former jointing compound designated Wellseal is no longer manufactured.

(1) Hylomar Universal Jointing Compound PL-32, medium grade (PWA 36000-3), is approved for use on threaded fittings. Hylomar Universal Jointing Compound PL-32, light grade (PWA 36000-4), is approved for use on metal-to-metal mating surfaces.

(2) Dow Corning No. 4 sealing compound is approved for use on threaded fittings or metal-to-metal mating surfaces. This compound may be used on gasket surfaces to reduce sticking to mating surfaces, and to ensure against slight seeping.

Exception: This compound shall not be used for applications involving silicone rubber or AN electrical connectors.

(3) Permatex Aviation Form-A-Gasket No. 3 and Parker Sealube sealing compounds are approved for use on threaded fittings and metal-to-metal mating surfaces.

(4) Permatex Form-A-Gasket No. 2 sealing compound is approved for use on threaded permanent lugs and inserts.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, LUBRICATING (PWA 585) APPLICATION (SPOP 153)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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REFERENCE MATERIAL REQUIRED

Title	Number
Phosphate Treatment (AMS 2481)	MIL-P-16232, Type M
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Vapor Degreaser (SPOP 3)	SWP 031 01
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, antigalling, lubricating, Dry Film (PWA 585)	Molykote X-15

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 585 lubricating compound. PWA 585-H specifies a high temperature cure, outlined in this subordinate work package.

2. PROCEDURE.

CAUTION

Any heat treatment or process involving temperature above 1200°F (649°C) shall be completed before using this subordinate work package.

a. Strip old compound from part per T.O. 2J-F100-53-1, SWP 031 14, SWP 031 15 or SWP 031 03.

CAUTION

After cleaning, handle only wearing clean gloves. Use extreme care to avoid contamination with oil, grease, or other foreign substance.

NOTE

If surface preparation is not required, none will be specified by WP/SWP.

b. Vapor degrease per T.O. 2J-F100-53-1, SWP 031 01 steps 2.a. through 2.e.

c. Phosphate treat carbon steel or low alloy steel parts only, per DOD-P-16232, Type M (AMS 2481).

d. Using masking tape, mask areas not to be coated.

e. Mount part in a fixture which holds the surface to be coated at right angles to spray mist. Do not hold parts by hand during coating.

NOTE

Variation in boundaries of areas to be coated shall be minus 0.000 to plus 0.125 inch.

f. Agitate compound vigorously immediately before spraying.

g. Apply coating in a fine mist with suitable spray gun or air brush, pressurized with approximately 40 psig dry oil-free air, or dry nitrogen.

h. Spray coating material in thin coats with a uniform sweeping motion, so that coating appears dry immediately on contact. Surface to be coated may be conditioned by either of the following:

   (1) Blow a stream of compressed, dry, oil-free air, or dry nitrogen across part while spraying.

   (2) Direct a heat lamp at surface being sprayed, but do not allow temperature of part to exceed 140°F (60°C).

i. Apply four coats to a total thickness of approximately 0.0009 inch unless otherwise required per WP/SWP.

j. Allow each coat to dry for approximately 30 minutes before applying the next coat, and after applying final coat.

k. Provide suitable protection against damage to surface during cure cycle.

l. Remove coated part from fixture and carefully remove masking tape.

m. Inspect surface for uniformity and absence of lumps or air bubbles. Color shall be gray-black.

n. Cure coating as follows:

   (1) Heat to 180° ±25°F (82° ±14°C); hold at heat for 2 hours.

   (2) Increase temperature to 300° ±25°F (149° ±14°C); hold at heat for 2 hours.

o. When coating PWA 585-H is specified per WP/SWP, continue cure cycle as follows:

   (1) Increase temperature to 400° ±25°F (204° ±14°C); hold at heat for 2 hours.

   (2) Increase temperature to 600° ±25°F (316° ±14°C); hold at heat for 2 hours.

   (3) Increase temperature to 700° ±25°F (371° ±14°C); hold at heat for 1 hour.

p. Cool to room temperature at a rate not exceeding 100°F (56°C) per hour.

q. Final coating shall meet the following conditions, or part shall be stripped and recoated.

   (1) Firmly bonded to basis metal.

   (2) Uniform in thickness and appearance.

   (3) Free from scratches, blisters, nodules, excessive porosity, edge buildup, or other imperfection which would prevent proper performance of part.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, ANTIGALLING (PWA 550) APPLICATION (SPOP 156)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, antigalling (PWA 550)	Sandstrom Hi-T 650 or Lubri-Bond HT

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 550 antigalling compound.

2. PROCEDURE.

CAUTION

- Any heat treatment or process involving temperature above 800°F (427°C) shall be completed before using this subordinate work package.
- After coating with PWA 550 antigalling compound, parts shall not be cleaned with petroleum solvents or preserved with petroleum-base compounds.

a. Strip old compound from part using T.O. 2J-F100-53-1, SWP 031 14 or SWP 031 15. Complete cleaning and preparation of part as directed per WP/SWP. If surface preparation is not required, none will be specified by WP/SWP.

b. Mix contents of container thoroughly before opening, until solids are uniformly dispersed. Solution is thin and requires no dilution. Solids tend to separate rapidly, so agitation or mixing is required throughout application to prevent settling.

NOTE

- PWA 550 antigalling compound is obtained by using PWA 550 antigalling compound as supplied (in paste form) for brushing or swabbing on parts.
- PWA 550 dip-type antigalling compound is obtained by thinning PWA 550 paste with xylene for dipping parts. Mix in suitable proportions so that runoff will leave required coating on part after slow dry. Keep tightly sealed during storage. Stir or mix thoroughly or shake well before using.
- PWA 550 spray-type antigalling compound is obtained by thinning PWA 550 paste with TT-T-548 toluene for spraying on parts. Mix in suitable proportions so that mixture is thin enough to apply with a spray gun. Keep tightly sealed during storage. Stir and mix thoroughly before using.

c. Application - Method A.

(1) Apply even coat of PWA 550 antigalling compound with suitable brush or swab to specified surface of part.

(2) Surface of part may be at room temperature, or part may be preheated to a maximum of 200°F (93°C) to improve flow-on of compound.

NOTE

Solution shall be agitated during immersion process.

d. Application - (Alternate) Method B. Apply coating to small hardware items, such as nuts and bolts, by immersing area to be coated in well-mixed solution of PWA 550 antigalling compound.

e. Application - (Alternate) Method C. Apply coating to parts by spraying a well-mixed solution of PWA 550 antigalling compound using a paint sprayer or air brush.

f. Apply coating to a thickness of 0.0003 to 0.0007 inch. Routine examination for specified thickness is not required.

NOTE

Parts may be handled after first half-hour of curing, but avoid touching coated surfaces.

g. Cure by air drying at room temperature for 18 hours minimum. Continued drying up to 72 hours may result in a somewhat improved cure.

Optional cure: Parts may be cured at elevated temperature, and for duration as follows:

- Aluminum or magnesium parts: 250° ±25°F (121° ±14°C) for 120 minutes.
- Cadmium plated parts: 450° ±25°F (232° ±14°C) for 60 minutes.
- Other alloys: 525° ±25°F (274° ±14°C) for 30 minutes, or at lower temperature, and for duration as specified above for aluminum, magnesium, or cadmium plated parts.

h. Normal appearance of cured coating is a soft, powdery film, easy to damage. Assemble parts carefully.

CAUTION

Do not use any abrasive substance for removing excess antigallant.

i. When necessary for fitting purposes, remove excess compound from mating parts by wiping with a cloth or by other means which will not expose underlying metal.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, ANTIGALLING (PWA 474) APPLICATION TO STEEL OR TITANIUM PARTS (SPOP 160)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information - - - - - - - - - - - - - -	T.O. 2J-F100-53-1
Cleaning Steel or Titanium Parts, Antigallant and Varnish Removal (SPOP 252) -	SWP 031 16
Cleaning, PWA 60 Graphite Varnish and PWA 474 Antigalling Compound Removal Titanium CompressorBlade Roots (SPOP 253, and SPOP 257) -	SWP 031 17

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Alcohol, denatured	O-E-760
Compound, antigalling (PWA 474)	LS 2065
Methyl ethyl ketone (MEK)	TT M-261
Toluene	TT-T-548

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 474 antigalling compound to steel or titanium parts.

2. PROCEDURE.

CAUTION

- Any heat treatment or process involving temperature above 700°F (371°C) shall be completed before using this subordinate work package.
- After coating with PWA 474 antigalling compound, parts shall not be cleaned with petroleum solvents or preserved with petroleum-base compounds.
- Do not use dry grit blast per T.O. 2J-F100-53-1, SWP 031 13 to remove old compound from compressor blade roots or disk blade slots. This type of grit blasting could cause uneven removal of material of part, resulting in uneven disk loading during engine operation.

a. Strip old compound from part using T.O. 2J-F100-53-1, SWP 031 17 or SWP 031 16. Complete cleaning and preparation of part as directed per WP/SWP. If surface preparation is not required, none will be specified by WP/SWP.

b. Preparation of thinner. Mix by volume as follows: one part O-E-760 denatured alcohol; one part TT-M-261 methyl ethyl ketone (MEK); and two parts TT-T-548 toluene.

c. Preparation of antigalling compound.

(1) Mix PWA 474 antigalling compound thoroughly by stirring or shaking.

(2) Thin, if necessary, with sufficient alcohol/MEK/toluene mixture to produce a sprayable consistency.

NOTE

Representative test specimen may also be coated same as part, in order to check completeness of final cure.

d. Apply at room temperature, or preheat part to 200°F (93°C) maximum to improve flow-on of compound.

e. Apply 474 antigalling compound by spraying. Brushing, swabbing, or dipping are acceptable alternatives, where spraying is not practical.

f. Air dry.

g. Apply additional coats as required until total thickness of 0.0003 to 0.0007 inch (approximate) is reached. Air dry following each coat.

h. Following final coat, air dry 30 minutes minimum.

i. Bake at 400° ±25°F (204° ±14°C) for 45 minutes minimum. Begin timed period when surface of part reaches approximately 400°F (204°C).

j. Air cool.

k. Check completeness of cure as follows: On representative test specimen, scrape off coating into a pile, using a sharp, flat instrument.

(1) If pile can be blown away easily as a powder, coating is adequately cured.

(2) If pile is gummy, cure is incomplete. Repeat heat treatment, or reprocess.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, ANTIGALLING AND CORROSION PREVENTIVE (PWA 559) APPLICATION (SPOP 161)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 4	0				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound, antigalling (PWA 559)	Fel-Pro C-652
Tetrachloroethylene (perchlorethylene)	O-T-236

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 559 antigalling and corrosion preventive compound.

2. PROCEDURE.

CAUTION

- Any heat treatment or process involving temperature above 700°F (371°C) shall be completed before using this subordinate work package.
- After coating with PWA 559 antigalling compound, parts shall not be cleaned with petroleum solvents or preserved with petroleum-base compounds.

a. Strip old compound from part per T.O. 2J-F100-53-1, SWP 031 14 or SWP 031 15. Complete cleaning and preparation of part as directed per WP/SWP. If surface preparation is not required, none will be specified by WP/SWP.

b. Stir or shake PWA 559 antigalling compound thoroughly, and thin, if necessary to produce a satisfactory consistency, using O-T-236 tetrachloroethylene (perchlorethylene).

NOTE

Representative test specimen may also be coated same as part, in order to check completeness of final cure.

c. Apply at room temperature, or preheat part to 200°F (93°C) maximum to improve flow-on of compound.

d. Apply PWA 559 antigalling compound by brushing. Swabbing or spraying are acceptable alternatives, if brushing is not practical.

e. Air dry.

f. Apply additional coats as necessary to achieve a total thickness of approximately 0.0007 inch. Routine examination for thickness is not required. Air dry between each coat.

g. Following final coat, air dry for 15 minutes.

h. Bake at 390° to 410°F (199° to 210°C) for 1 hour; or at 290° to 310°F (143° to 154°C) for 2 hours. Begin timed period when surface of part reaches the approximate baking temperature.

NOTE

Discoloration of cadmium plate as a result of this bake shall not be cause for rejection.

i. Air-cool.

j. Check completeness of cure as follows: On representative test specimen, scrape off coating into a pile, using a sharp, flat instrument.

(1) If pile can be blown away easily as a powder, coating is adequately cured.

(2) If pile is gummy, cure is incomplete. Repeat heat treatment, or reprocess.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, LOCTITE 40 ADHESIVE (PWA 549, TYPE II) APPLICATION (SPOP 163)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Cheesecloth, unsized	CCC-C-440
Compound, retaining, anaerobic adhesive, Loctite 40 (PWA 549, Type II)	MIL-R-46082, Type II
Grit, aluminum oxide, No. 90	Blastite BT No. 90 or Arrow Blast No. 90 or Fastblast No. 90 or No. 90 Dyna Blast
Methyl ethyl ketone (MEK)	TT-M-261
Primer, activator, Locquic Primer T	MIL-S-22473, Grade T (yellow)
Tetrachloroethylene (perchlorethylene)	O-T-236
Trichloroethane	MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 549, Type II anaerobic adhesive compound (Loctite 40).

2. PROCEDURE.

a. Degrease parts using either O-T-236 tetrachloroethylene (perchlorethylene), or MIL-T-81533 trichloroethane.

b. Prepare bonding surfaces by either abrasive cleaning with No. 180 emery cloth, or grit blasting with No. 90 aluminum oxide.

c. Wipe surface with unsized cheesecloth moistened with TT-M-261 methyl ethyl ketone.

d. Air dry for 10 to 15 minutes.

e. Prime all surfaces to be bonded, using Locquic Primer T activator aerosol spray. Exception: Omit for nonpassivated steel and nonanodized aluminum.

f. Air dry for 3 to 5 minutes.

g. Apply PWA 549, Type II (Loctite No. 40) anaerobic adhesive by brushing or swabbing all surfaces to be bonded. Ensure that wetting by compound is complete.

h. After assembly and fixturing as required, remove excess adhesive.

i. Cure adhesive by either of following options:

(1) Room temperature for 24 hours minimum at 50% relative humidity.

(2) (Alternate method) Bake 30 to 60 minutes at 275° ±25°F (135° ±14°C).

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, ANTIGALLING (PWA 36545) APPLICATION (SPOP 748)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
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3	11				
4	12				

REFERENCE MATERIAL REQUIRED

Title	Number
Introduction and General Information	T.O. 2J-F100-53-1
Cleaning, Glass Bead Blast, Wet (SPOP 16)	SWP 031 03
Cleaning Steel, Magnesium, or Titanium Parts, Paint and Varnish Removal (SPOP 250)	SWP 031 14
Cleaning Aluminum Parts, Paint and Varnish Removal (SPOP 251)	SWP 031 15

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
ALCOHOL, METHYL	O-M-232
COMPOUND, ANTIGALLING (PWA 36545)	EVERLUBE 382 OR KAYLUBE NO. 3
METHYL ETHYL KETONE	TT-M-261
TOLUENE	TT-T-548
WATER, DISTILLED OR DEIONIZED (PMC 1737)	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This subordinate work package contains instructions for depot maintenance application of PWA 36545 antigalling compound.

2. PROCEDURE.

NOTE

- All antigallant shall be removed before any process involving temperatures above 900°F (428°C) is performed.
- Any heat treatment or other process involving temperature above 900°F (428°C) shall be completed before using this SWP.
- After coating with PWA 36545 antigalling compound, parts shall not be cleaned with petroleum solvent or preserved with petroleum-base compounds.

a. Strip old compound from part per SWP 031 14, SWP 031 15, or SWP 031 03. Complete cleaning and preparation of part as directed. If surface preparation is not required, none will be specified by WP/SWP.

NOTE

Representative test specimens may also be coated same as parts, in order to check completeness of cure.

b. Mask as required. Variation in boundaries of areas to be coated shall be minus 0.000 to plus 0.125 inch. Variation in boundaries of areas not to be coated shall be plus 0.000 to minus 0.125 inch.

c. Apply coating to a thickness sufficient to prevent base metal from being exposed, using one of the following methods.

d. Application - Method A.

(1) Stir compound vigorously immediately before application.

(2) Apply even coat of compound by brushing or by swabbing.

(3) Bake parts per step g.

e. Application - (Alternate) Method B.

(1) Apply coating to small hardware items, such as nuts and bolts, by immersing area to be coated. Compound shall be agitated during immersion procedure. If fixtures or trays are used, ensure proper application on all areas of parts to be coated.

(2) Bake parts. Refer to paragraph 2.g.

(3) Immerse coated parts a second time in agitated compound.

(4) Bake parts. Refer to paragraph 2.g.

f. Application - (Alternate) Method C.

(1) Thin antigalling compound with sufficient TT-T-548 toluene or distilled water to produce a sprayable consistency. Mix thoroughly.

(2) Apply coating to parts by spraying with compound thinned with toluene.

(3) Bake parts. Refer to paragraph 2.g.

g. Bake cycle for coated parts.

(1) When necessary for fitting purposes, coated surfaces of mating parts shall have excess material removed by wiping with a cloth or by other means without exposing underlying metal. Abrasives shall not be used.

(2) Bake for 2 hours at 140° to 160°F (60° to 71°C).

(3) Bake for 2 hours at 390° to 410°F (199° to 210°C).

h. Cure may be checked for completeness as follows:

(1) On a representative test specimen, rub the coated surface briskly with a clean, cotton swab which has been moistened with methyl alcohol or methyl ethyl ketone, approximately 10 strokes, applying moderate pressure.

NOTE

A slight discoloration of the swab is permissible.

(2) If substrate metal is exposed, coating is not adequately cured. Repeat bake cycle on coated part.

SUBORDINATE WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES - COMPOUND, SEALANT (PWA 552) APPLICATION

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE SWP PAGES

Total Number of Pages in this SWP is 4

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1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Compound sealant (PWA 552)	SermaBond 481
Grit, aluminum oxide (PMC 3043)	90 to 120 grit
Sodium hydroxide (Caustic soda)(PMC 1807)	Reagent grade
Trichloroethane, inhibited 1,1,1 (PMC 9056)	MIL-T-81533

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for application of PWA 552 sealing compound.

2. PREPARATION.

CAUTION

Wear lint-free cotton gloves when handling cleaned surface area.

a. Clean surface area to be bonded. Surface area shall be free of oil, grease, or paint films. Vapor degrease area with 1,1,1-trichloroethane or equivalent.

b. Grit blast with 90 to 120 mesh aluminum oxide to produce a surface profile suitable for bonding.

NOTE

Sermabond 481 is shipped as a two part mix and has a 6 month shelf life when stored at 35 to 45°F (2 to 7°C). After combining Parts I and II, shelf life is limited to 2 weeks.

NOTE

Avoid stirring too rapidly or air entrapment may result.

c. Shake Part I to ensure complete mixing. Transfer Part I to a suitable plastic container, and stir while adding Part II powder.

d. Allow mixed materials to stand 18 to 20 hours before application.

3. APPLICATION.

a. Apply PWA 552 sealant to open areas with a spatula or straight flexible metal blade. Use a hypodermic syringe for narrow or confined areas.

b. Air dry sealant for a minimum of 12 hours prior to heat treatment.

c. Heat treat sealant parts incrementally:

2 hours at 140°F ±5° (60°C ±3°)
1 hour at 175°F ±5° (79°C ±3°)
1 hour at 200°F ±5° (93°C ±3°)
1 hour at 360°F ±5° (182°C ±3°)

4. REMOVAL.

a. Soak sealant parts in a caustic solution to soften cement. Make a solution of 5 pounds of sodium hydroxide per gallon of water, and heat to 180°F ±5° (82°C ±3°). Remove sealant. Rinse in hot water, then cold water and air dry.

WORK PACKAGE

TECHNICAL PROCEDURES

GENERAL REPAIR PROCEDURES -

COMPOSITE REPAIR PROCEDURES, GENERAL

EFFECTIVITY: ENGINE MODELS F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 12

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 11	10				
12 Blank	10				

REFERENCE MATERIAL REQUIRED

Title	Number
General Advanced Composite Repair Processes Manual ------	T.O. 1-1-690
Nondestructive Inspection Methods -----------------	T.O. 33B-1-1

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
Acetone (PMC 9008)	O-A-51
Alcohol, methyl	O-M-232
Alcohol, isopropyl (PMC 9094)	TT-I-735
Bag, plastic	-
Cloth, abrasive, aluminum oxide	80, 100, 120,150, 180 grits
Cloth, abrasive, silicon carbide	240, 280, 320 grits
Cloth, dry, lint-free	-
Gloves, lint-free	-
Methyl ethyl ketone (MEK)	ASTM-D-740
Pencil (Crayon), Metal marking (hard)	Colorbrite Silver No. 2101
Sheet, plastic, clear	-

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains instructions for depot maintenance repair of composite materials.

2. SOURCES OF DAMAGE.

a. Composite structures are designed to be durable components having a long service life. Damage to these components can be caused by conditions which occur on a random basis during service operation. Sources of damage can include:

- Collision with ground service vehicles
- Collision with work stands and ladders
- FOD from rocks, gravel, etc.
- Excessive heat
- Tools
- Edge damage
- Lightning strike
- Ballistics

3. TERMS AND DEFINITIONS.

a. Terms used to describe damage and conditions appropriate to composite structures and their cause are as follows:

TERM	DEFINITION
Abrasion	A wearing away of laminate surface; may extend into fiber. Caused by environmental conditions (rain, dust, sand, etc.) and mechanical conditions (misfit, oversanding, etc.).
Blister	A raised area; pillow-like; soft or hard; can be depressed by applying pressure; close to the laminate outer surface. Caused by partial entrapment of volatiles (solvents that hold resin in solution) during cure. Treat as a delamination.
Crazing	A lace-like network of minute cracks. Caused by improper handling and mechanical impact.
Debond	Separation at an adhesive bond line. Caused by improper processing, marginal adhesive, or built-in bonding stresses.
Delamination	Separation of adjacent composite plies. Caused by rough handling, poor interlaminar adhesion, or improper machining procedures.

TERM	DEFINITION
Erosion	Surface abrasion. Caused by environmental conditions (rain, dust, dirt, hail, etc.).
Fracture/ splintering	Cracks in laminate matrix or fiber; combined cracking and delamination of laminate outer fibers. Caused by improper handling or minor mechanical impact.
Gouge	Elongated surface discontinuity extending through one or several laminated plies from removed matrix and fiber. Caused by tool damage during machining, or contact with sharp object.
Hairline flaw	A very fine, linear flaw. Similar to a minute crack which will not cause a 0.062 inch radius stylus to catch or hesitate when passed across the surface. Caused by environmental or mechanical condidions.
Matrix/ fiber degradation	Breakdown of composite structure. Caused by sonic and/or mechanical fatigue.
Matrix degradation	Breakdown of matrix material.Caused by chemical attack or excessive and local exposure to high heat.
Orientation	Position or direction of prepreg weave relative to a coordinated axis established for a part.
Penetration	Breaking through of a laminate surface (totally through the panel). Caused by impact.
Ply	A single layer of prepreg, single thickness of cloth.

TERM	DEFINITION
Porosity	Similar to voids only microscopic in size.
Prepreg	Resin impregnated continuous fiber, either unidirectional (tape), woven, knit, or nonwoven.
Recess	Molded-in depression in laminate. Caused by foreign object on mold surface.
Resin blister	A localized lifting of resin appearing as a bulge that may break when probed. Does not extend into fibers. Caused by partial entrapment of volatiles during cure.
Scarf	A joint made by cutting material at an angle so that repair patches can overlap and join firmly.
Scratch	Elongated surface discontinuity that is small in width compared with length. Caused by contact with sharp-edge object.
Tracer lines	Exposed fiber. Brown to light tan in color. Appears as dashed lines along the length of part. Indicates direction of fiber weave.
Void	An open area contained within the laminate; no apparent changes in laminate thickness; generally small. Caused by volatile entrapment during cure.
Wrinkle	A wave or uplifting of one or more layers of fiber resulting in a greater thickness or change in amount of resin filling local area. Caused by defects during curing.

4. INSPECTION METHODS.

a. The primary test for inspecting composite structures is visual inspection. Visual inspection can be used in conjunction with the following:

(1) Tap Testing (or Manual Sonic Testing):

(a) Visual inspections and tap testing are intended for use on panels that have been placed in service after passing all manufacturing acceptance tests and inspections.

(b) Tap testing is used primarily for exploring and determining boundaries of suspected delamination which have occurred in bonded composite laminated panel structures. Refer to T.O. 1-1-690. A delamination occurs when the bonding agent between two laminas fails, which reduces the strength and rigidity of the structure. Bonding agent failure may not be visible on the structure surface.

(c) Test operates on principle of resonance of part being tested. Test is confined to audible range of 16 to 20,000 hertz. Part is tapped or struck lightly with a small metal rod with a smooth round or ball end. Tap rate is approximately 4 taps per second, while moving rod in a regular survey pattern across surface of panel under test. If panel material is solid homogenous construction and thickness in area directly beneath point of rod impact, part will emit uniform sonic vibrations at a pitch which is characteristic for material at that thickness. If a void or a delamination is present directly beneath point of rod impact, it is evidenced by an abrupt change in pitch of the sound emitted by panel.

(2) Ultrasonic Testing:

(a) Ultrasonic C-scan immersion imaging techniques are used to detect delamination, porosity, voids and unbonds within layers of composite structures. Refer to T.O. 33B-1-1.

5. REPAIR REQUIREMENTS AND REPAIR CLASSIFICATION.

a. Loading variances within a composite component make it necessary to determine the maximum allowable serviceable and reparable damage limits, and establish which type of repair(s) will return full life to part. It is also necessary to use dimensions that can be established from reference points on any given part so maintenance personnel can determine in which inspection/ repair zone the damage occurred. Once this has been accomplished, the applicable inspection and/or repair limits can be applied.

b. Terms used to describe damage classification are as follows:

TERM	DEFINITION
Negligible	Damage that requires no rework other than possible surface refinishing. Damage may consist of minor dents, scratches, or voids that result in no degradation of structural performance or integrity. Damage requires no repair over the design life of the structure.
Reparable	Damage that requires rework of various degrees to return component to full life status. Reparable damage types are defined and classified according to damage cause as follows:

TYPE	CAUSE OF DAMAGE
Processing defects	Built in during repair process (voids, blisters, etc.).
Mechanical defects	Result from mechanical damage during service or in-service deterioration (handling, excessive loads, ballistic penetration, etc.).
Degradation	In-service deterioration that results from environmental damage (rain, lightning, weathering, etc.).

TERM	DEFINITION
Nonreparable	Damage in which the structure cannot be restored to a satisfactory condition due to cost, technical or design life limitations.

6. SURFACE FINISH.

a. Repairs applied to an interior non-air-wetted (non-airflow) surface, require no smoothing except to remove jagged flash that might cause injury to personnel or interfere with adjacent parts or structures.

b. Repairs applied to an exterior, or interior air-wetted (airflow) surfaces, require aerodynamic smoothing.

c. Adding a top ply of prepreg in addition to plies required to provide material which may be sanded and smoother to a feather edge for suitable airflow contour is permissible.

d. Removal of any fibers of graphite repair plies or adjacent parent plies during sanding operation is not permitted.

e. Depressions or discontinuities that remain in repair surface may be sanded and cleaned with a clean cloth soaked with methyl ethyl ketone (MEK), isopropyl alcohol, methyl alcohol, or acetone, then filled with an epoxy or polymer that will tolerate the service environment and smooth sanded, if permitted by the appropriate WP/SWP.

7. COMPOSITE REPAIR STANDARD PRACTICES.

a. Certain standard practice shall be followed and precautions observed to assure integrity of repair, and health and safety of affected personnel as follows:

(1) Environmental Precautions:

(a) Procedures for control and disposition of waste material generated during this repair process shall conform to Environmental Protection Agency (EPA), state, and local requirements.

(b) Control room shall conform to MIL-A-83377B or better depending upon requirements of specific process.

(c) Repair shall be performed in a controlled room designed to protect repair process from dust, moisture, oil mist, exhaust fumes and particulate matter which may contaminate repair, or affect cure rate or adhesion of repair material/process.

(d) Aerosols shall be controlled as they may act as release agents between plies.

(e) Repair area shall be well ventilated to carry off fumes from cleaning solvents, adhesive vapors, and dust generated from repair procedures.

(f) Flammable cleaning solvents are used and require provisions to keep from heat and open flames. Fire control equipment should be immediately available.

(g) Vacuum dust-removal equipment should be provided to remove dust generated by sanding, grinding, or cutting of composite materials.

(h) Tool preparation and cleaning areas shall be remote from lay-up or bond/assembly areas to ensure cleaning material and release agents shall not migrate into these sensitive areas.

(2) Grinding/Sanding Material:

(a) Only silicone carbide and aluminum oxide abrasives, or diamond tools shall be used on composite materials.

(3) Surface Finish:

(a) Surface finishes (coatings, paints, etc.) shall be removed from repair area(s) with 80 to 180 grit abrasive cloth. 240 to 320 grit abrasive cloth shall be used to smooth repaired surface area(s) to a dull matte finish with all gloss removed.

(b) Areas not requiring sanding shall be masked as necessary. Sanding dust shall be removed with a clean cloth soaked with methyl ethyl ketone, isopropyl alcohol, methyl alcohol, or acetone, before solvent evaporates.

(4) Health and Safety Practices:

(a) Repair area shall be well ventilated.

(b) Gloves and protective clothing shall be worn when handling composite repair material, adhesive and solvents.

(c) Excessive breathing of fumes from adhesive resin and cleaning solvents shall be avoided.

(d) Dust mask and safety glasses shall be worn when cutting or sanding composite structures.

(e) When removing material, the use of a vacuum is recommended.

(f) Hands shall be washed before eating or smoking.

8. GENERAL REPAIR PROCEDURES. (See Figure 1.)

a. General repair procedures apply to damage incurred by a composite structure which exceeds maximum serviceable limits. General repair procedures are as follows:

(1) Steam clean part.

(2) Visually inspect damage.

(3) Outline damage on part using a silver pencil (crayon). (See figure 1.)

NOTE

- Shape of repair area shall include damaged area, airflow, surrounding structure, non-reparable areas, and ease of repair.
- Minimum repair outline radius is 0.500 inch.

(4) Outline shape of repair area. (See figure 1.)

NOTE

To provide operator control and prevent aggressive material removal when using hand held power tools to remove composite material when creating scarf angle, use of standard sanding disks or grinding wheels is recommended.

(5) Remove damage using one of the following methods:

(a) Method I:

1 Machine away plies using tools that will produce a scarf angle specified in appropriate WP/SWP, or blend away material using a template of scarf angle as a guide. (See figure 1.)

NOTE

Template material, construction, and thickness may vary from plies being removed.

2 Construct first template so shape of scarfed area is covered.

3 Construct progressively smaller templates so when plies are layered in scarfed-out area, a scarf angle specified by appropriate WP/SWP will be produced by layers of templates.

4 Construct two additional templates for overlay plies. Make templates approximately 0.300 inch larger than shape of repair shape, or first constructed template.

(b) Method II:

NOTE

Template material, construction, and thickness may vary from plies being removed.

1 Construct template of outlined repair area.

2 Construct additional templates progressively smaller so the required scarf angle specified by appropriate WP/SWP will be produced.

3 Remove material ply-by-ply so templates match layer of material removed. (See figure 1.)

4 Construct two additional templates for overlay plies. Make templates approximately 0.300 inch larger than shape of repair shape, or first constructed template.

(c) Method III:

1 Remove plies using tools that will produce a scarf angle specified by appropriate WP/SWP, or blend away material using a template of scarf angle as a guide. (See figure 1.)

2 Lay a clear piece of plastic over scarfed out area. Trace outline/location of plies onto plastic. Draw an additional line for an overlay ply approximately 0.300 inch larger than repair shape.

CAUTION

Entrapped moisture will degrade properties of a repair if sufficient amount of moisture is not removed from part.

(6) Dry parts in an oven at a sufficient temperature and time to remove entrapped moisture in composite material.

(7) Clean parts using a clean cloth soaked with methyl ethyl ketone, isopropyl alcohol, methyl alcohol, or acetone.

(8) Place parts in plastic bags to prevent contamination, if necessary.

CAUTION

To prevent part contamination, composite material lay up shall be performed in a controlled environment room.

NOTE

- Template material, construction, and thickness may vary from plies being removed.
- Template transfer to repair material may vary.
- Number of repair plies shall equal number of damaged plies removed. Number of repair plies does not include fill plies or overlay plies, except when modified by applicable WP/SWP. (See figure 1.)
- Orientation of repair plies is controlled by appropriate WP/SWP.

(9) Transfer template outline to patch material and cut to size. Maintain weave orientation as required by appropriate WP/SWP.

(10) Impregnate patch material and coat repair area with adhesive, if required.

(11) Lay impregnated patch material in repair area as specified in appropriate WP/SWP. Lay patch material so scarf angle is matched by offset plies. (See figure 1.)

(12) Place part into tooling specified in appropriate WP/SWP, if required.

(13) Cure repair part as specified in appropriate WP/SWP.

(14) After parts have been cured inspect parts as specified in appropriate WP/SWP.

(15) Sand parts with 240 to 320 grit abrasive cloth to remove excess resins, irregularities, or sharp edges per this WP.

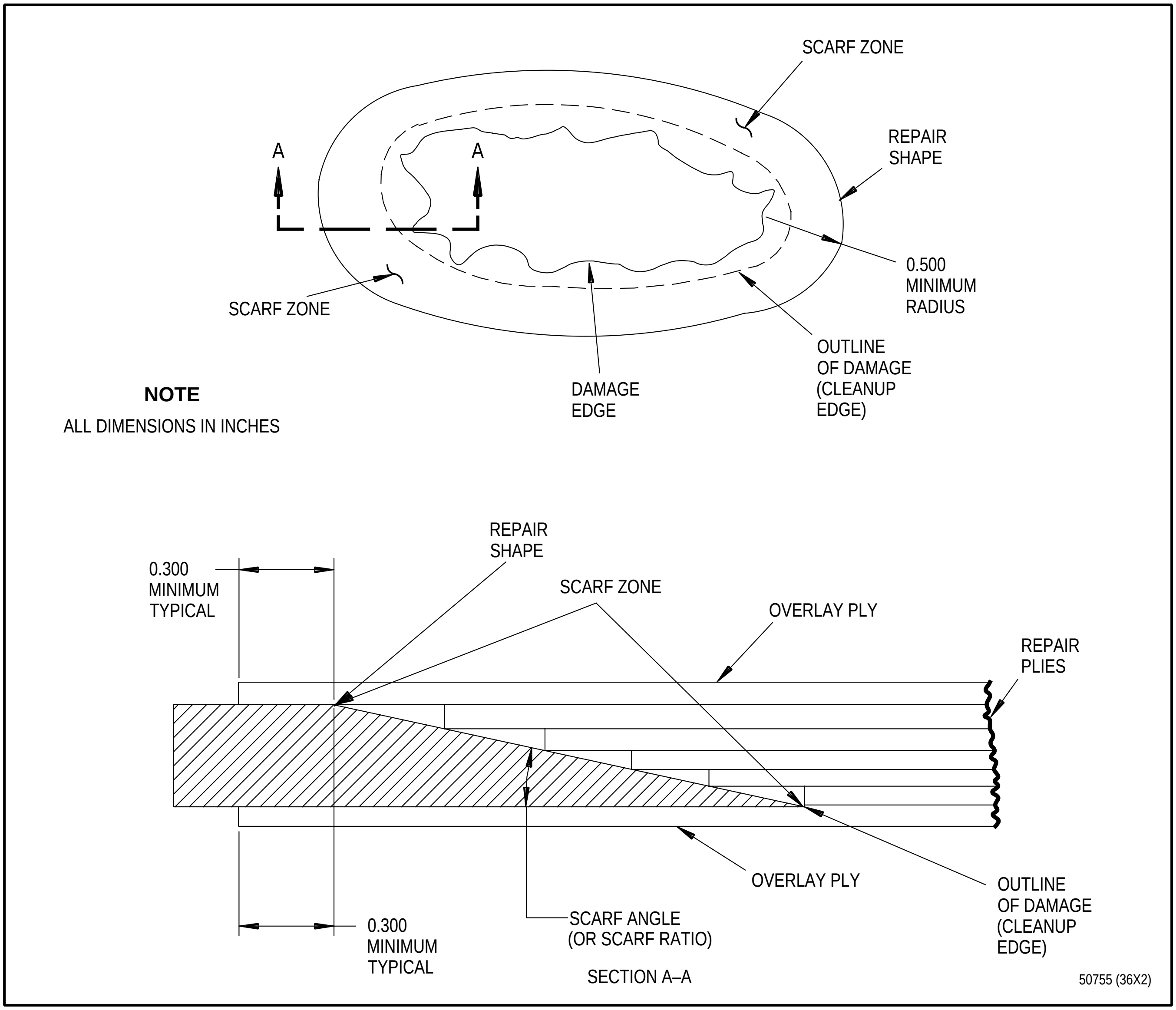


Figure 1. Composite Parts - Repair

WORK PACKAGE

TECHNICAL PROCEDURES

SILICONE RUBBER (PWA 407) - GENERAL STORAGE, PREPARATION, AND APPLICATION INSTRUCTIONS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 14

REFERENCE MATERIAL REQUIRED

Title	Number
Standard Maintenance Procedures	T.O. 2-1-111
Introduction and General Information	T.O. 2J-F100-53-1
Nondestructive Test of Rubber To Metal Bond using PWA 52879 Checking Fixture	WP 101 00
Support Equipment and Numerical Tool List	T.O. 2J-F100-53-3
Silicon Rubber Mold Fixtures - Cleaning and Repair	WP TBD 00
Inlet/Fan Module	T.O. 2J-F100-53-6
Shroud, Front Compressor Stator, Inlet - Repair	WP 411 00

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

Nomenclature	Specification/Vendor Part Number
CHEESECLOTH, UNSIZED	CCC-C-440
CLOTH, ABRASIVE, ALUMINUM OXIDE	320 GRIT
CLOTH, ABRASIVE, SILICON CARBIDE	90 GRIT SILICON CARBIDE
COMPOUND, SILICONE, RUBBER	PWA 407 VISILOX V-622
ISOPROPYL ALCOHOL	TT-I-735
PAPER, KRAFT 50# (PMC 4128)	MEDIUM DUTY KRAFT
PRIMER, ADHESIVE/SEALANT	PWA 556 VISILOX V-06
SOLUTION, CLEANING	PASA-JELL 107
TAPE, MASKING METALLIC (LEAD FOIL) (PMC 4138)	SCOTCH NO. 421 LEAD FOIL TAPE
TAPE, MASKING, GENERAL PURPOSE	SCOTCH NO. 232 OR TUCK NO. 122 OR PERMACEL NO. 701

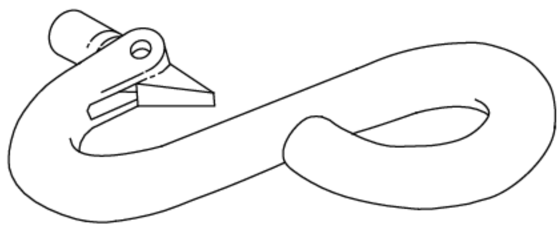
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

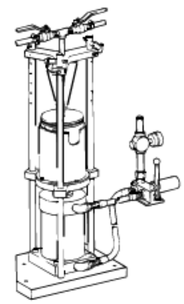
Paragraph	Function - Tool Nomenclature	Tool Number
2	SILICONE RUBBER (PWA 407) - GENERAL STORAGE, PREPARATION, AND APPLICATION INSTRUCTIONS	
	DISPENSER ----------------------------	PWA 26443
	HOOK -------------------------------	PWA 2388

ILLUSTRATED SUPPORT EQUIPMENT



PWA 2388 –C

Figure T1. PWA 2388 HOOK



PWA 26443 –C

Figure T2. PWA 26443 DISPENSER

1. INTRODUCTION.

a. This work package contains instructions for silicone rubber (PWA 407) general storage, preparation and application.

2. SILICONE RUBBER (PWA 407) - GENERAL STORAGE, PREPARATION, AND APPLICATION INSTRUCTIONS.

(See Figure 1.)

CAUTION

Compound and curing agent are supplied in matching sets. To avoid incorrect application of compounds, interchanging of components between sets is not permitted.

a. Ensure PWA 26443 dispenser is clean.

b. Ensure mold fixtures are clean. If not, refer to T.O. 2J-F100-53-3, WP TBDfor cleaning procedures.

c. For those mold fixture details with Teflon coating, ensure coating is undamaged. Refer T.O. 2J-F100-53-3, WP TBD for repair procedures.

CAUTION

When removing rubber, care shall be exercised to prevent damage to parent material which could effect rubber contour.

d. Remove old silicone rubber from parent material by cutting with razor blade, knife, or a clean plastic chisel-type tool. Remove remaining rubber by using air driven rotary stainless steel wire brush. Do not generate heat.

Legend for Figure 1

1. Ball Valve
2. Quick Release Pin
3. Pipe Nipple (Air Inlet)
4. Regulator
5. Bellows Valve
6. Air Cylinder
7. Shield Assembly
8. Piston
9. Plunger Assembly
10. Rod

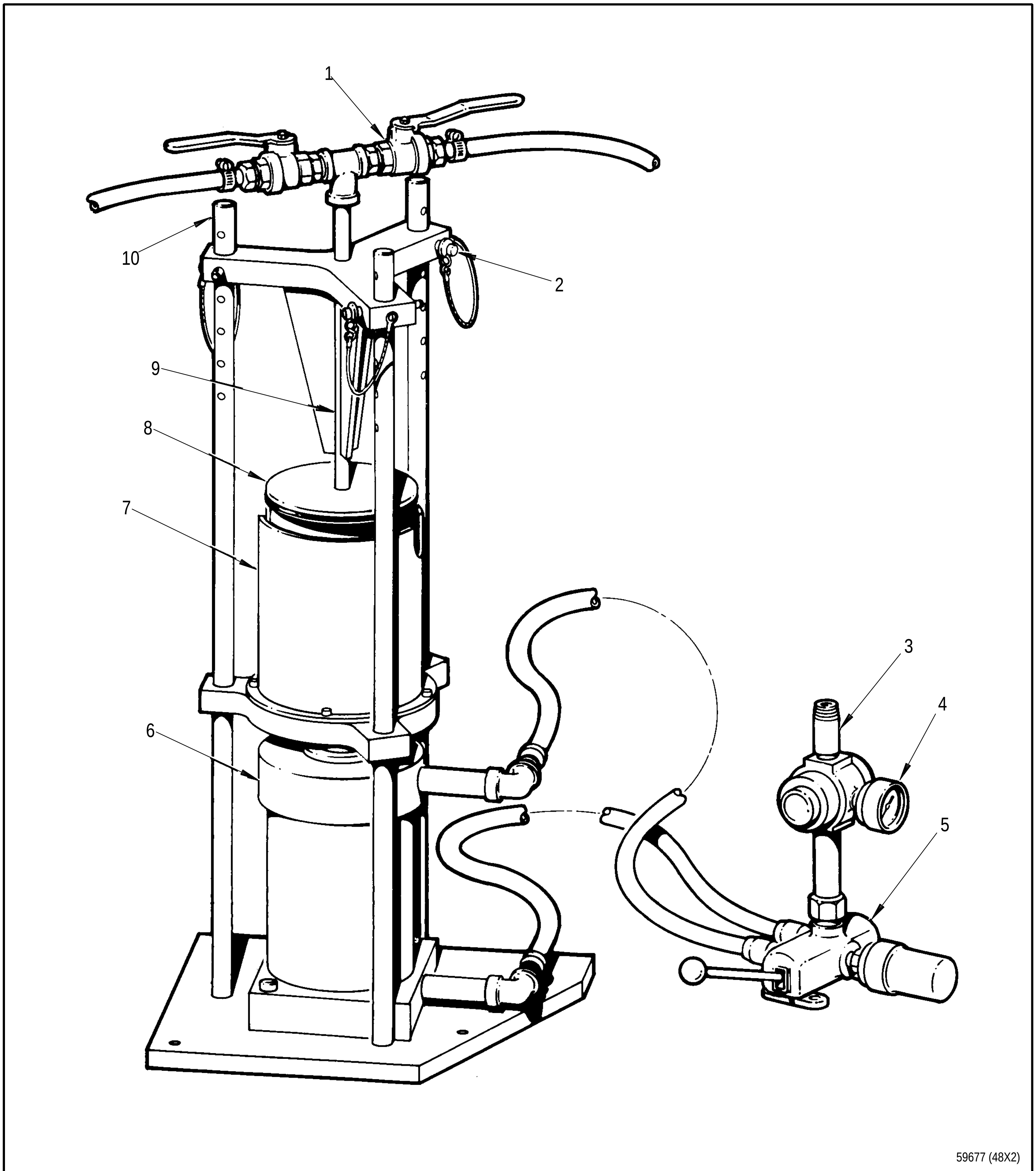


Figure 1. PWA 26443 Dispenser - Use

CAUTION

To avoid contamination of bond surfaces, comply with the following:

- Sized cheesecloth has resin binder joints and edges which may dissolve in isopropyl alcohol and contaminate bond surfaces. Isopropyl alcohol dispensers should be squirt or pour-types to avoid repeated dipping and contamination with work cloths.
- Facilities should be available to determine that each batch of isopropyl alcohol supplied to depot is free of organic contaminants.
- Cleaned parts shall be handled only with clean nylon gloves while avoiding contact with areas to be bonded.
- When parts are not in clean room, wrap in neutral Kraft paper.
- If there is more than one hour exposure between operations in clean room, cover parts loosely with neutral Kraft paper. Other papers or plastic sheets may have wax substance on their surfaces which can contaminate rubber bond.

NOTE

- Mask around area of part to be rubber filled prior to grit blast.
- Following grit blast, masking tape should be removed from part prior to wiping with isopropyl alcohol. Isopropyl alcohol will attack residual masking tape and cause blast residue to stick.
- It is not necessary to remask part prior to primer application.
- Excess primer applied outside of area to be rubber filled, can be wiped off while primer is still wet, using clean, unsized cheesecloth, moistened with isopropyl alcohol.

e. Prepare area to be bonded as follows:

(1) Using general purpose masking tape, mask areas adjacent to area to be rubber filled.

(2) Clean bond area per PWA 83-B1 using 90 grit or coarser at 50 to 70 psig. Refer to T.O. 2-1-111.

(3) Optional cleaning method.

(a) Using clean, unsized cheesecloth moistened with isopropyl alcohol, clean area to bonded.

(b) Using 320 grit aluminum oxide wet or dry abrasive paper, clean bond area to remove foreign material and surface finish.

(c) Mask area adjacent to bond area using lead foil or polyester tape.

(d) Using clean unsized cheesecloth, moistened with isopropyl alcohol, clean sanded area. Change cloth frequently until all evidence of sand residue is removed.

CAUTION

Pasa-Jell 107 will cause corrosion when allowed to enter unsealed joints and recesses.

(e) Mask unsealed joints and recesses.

(f) Brush coat Pasa-Jell 107 on area to be bonded, allow to remain for 12 to 16 minutes.

(g) Using distilled or demineralized water, rinse coated area, unsealed joints and recesses. Use blue litmus paper to check for removal of all acid.

(h) Dry treated area at room temperature or at 150°F (65.6°C) with a heat lamp.

(i) Protect cleaned area with kraft paper if case is not to be rubber filled immediately.

NOTE

- PWA 556 primer has a 6 month shelf life when stored at temperatures not exceeding 90°F (32°C) in metal containers sealed by the manufacturer. Discard any primer not used before the expiration date.
- Decant in a clean glass bottle only the required amount of primer from the supply bottle that will be used on part being processed. Discard any excess decanted primer after coating part.
- Very light coat of primer will provide good bonding surface. Color should be barely visible pink. One pass only with applicator is recommended because more than one coat of primer, chalky pink color, can adversely affect bond strength.

f. Within 1/2 hour after cleaning, using nylon bristle paint brush for each part, apply PWA 556 primer 0.0001 inch thick to bonding surface and allow to dry at 77°F (25°C), relative humidity 50% minimum or equivalent moisture level for 2 hours minimum.

NOTE

Discard any unused primer after 1/2 hour of exposure to air. Expiration date is to be 45 days after repackaging or the expiration of the original container, whichever is sooner. Discard all primer which is not used prior to expiration date.

g. Repackage primer into new, dry, clean glass container and cap tightly. Discard any remaining primer after 1/2 hour. Label bottles with following information:

Primer (PWA 556)
Lot No.of Primer
Date of Repackage
Expiration Date

h. Clean application brush after each batch of primer using isopropyl alcohol.

i. Remove masking from part. Use caution not to contact area to be bonded, clean excess primer from areas adjacent to bonding surface, using isopropyl alcohol.

CAUTION

To avoid bond surface contamination, comply with the following:

- Bonding operation shall commence after 2 hours and be completed within 24 hours following application of primer.
- Primed parts shall be dried and maintained in a dust-free location until bonding operation.

NOTE

- Silicone rubber has a shelf life of at least 6 months from date of shipment when stored below 90°F(32°C) in manufacturer’s sealed container. Shelf life will be less if stored at higher temperatures. Use after 6 months may give unsatisfactory results. Shelf life extensions of 1 month may be made on outdated material provided viscosity is within specification. Viscosity at 74° to 77°F (23° to 27°C), poise: Brookfield Visometer Model HAF No. 7 spindle at 10 rpm or equivalent. Mod Measurement to be made 2 minutes after starting spindle rotation.

- As received --------- 2500 to 5000

  After mixing with curing agent and standing 4 hours ----------- 1300 to 3500

- Silicone rubber compound in the mixed condition has a working life of at least four hours when maintained at temperatures not exceeding 80°F (27°C). Mix only that amount of material which will be used within 4 hours.
- Best mixing results (after addition of curing agent to rubber compound) are obtained by use of a locally fabricated metal stirrer (butterfly-type paddle) motor driven at approximately 400 rpm. Manual stirring is time consuming and may not give a homogeneous mixture. Incomplete mixing can result in soft spots (low durometer reading) in cured rubber.

j. Combine 100 parts silicone rubber compound (PWA 407) with 10 parts curing agent by weight. Mix thoroughly at 70° to 80°F (21° to 27°C) using a locally fabricated metal stirrer (butterfly-type paddle) motor driven at approximately 400 rpm or by manual stirring for 8 to 10 minutes.

k. Remove air from mixture by applying a 27 to 29 inch vacuum for 60 minutes using vacuum pump assembly, Model 0522-V3 G18 DY, available from Gast Manufacturing Company, Dept A, Box 97, Benton Harbor, Michigan 49022 and Bell Jar Assembly Model 5305-0609, Nalge Company, Rochester, New York 14602, or equivalent. Reference F.E. No. RG-8.

WARNING

Do not connect air supply to PWA 26443 dispenser prior to installing silicone rubber filled cannister to preclude personal injury, if switch is activated when loading cannister.

NOTE

- Tee joint and liquid rubber shutoff valves at top dispenser should be removed and retained for use only when it is desired to fill two molds simultaneously because tee joint and shutoff valves are difficult to clean and are not necessary when injecting single molds (90% of applications).
- Air can become entrapped in shutoff leg of tee joint during single pour applications and bleed air bubbles into liquid rubber during injection process.

l. Install cannister into PWA 26443 dispenser as follows:

(1) With air cylinder(6, figure 1) in full retracted position, remove three pins(2) from plunger assembly(9).

(2) Remove plunger assembly(9) and install rubber filled cannister into shield assembly(7), ensuring handle position on cannister engages slots in shield assembly.

(3) Reinstall plunger assembly(9) over rod details(10) and engage piston(8) into ID of cannister.

(4) Open valves(1) and exert hand pressure on plunger assembly(9). Insert pins(2) through rod details(10) and plunger assembly(9) to secure.

m. Brush coat mold fixture rubber contact surface and injection nozzles with mold release agent. Allow to dry. Excess compound should be wiped off mold fixture and nozzles with clean cheesecloth prior to placing part into mold fixture.

n. Install engine part into mold fixture per applicable specific repair paragraph.

NOTE

Prior to connecting hose to mold fixture, discard first several ounces of rubber to flow through PWA 26443 dispenser.

o. Using PWA 26443 dispenser with shop air, inject silicone rubber into mold fixture as follows:

NOTE

If voids start to develop while injecting silicone rubber, reduce air pressure to eliminate voids.

(1) Ensure valve(5) is closed.

(2) Attach air supply to air inlet(3). Set regulator(4) to 30 to 80 psig.

(3) Attach short piece of 1/2 to 3/8 inch ID, vinyl tube to top (outlet) nozzle of mold fixture. Secure with standard hose clamp.

(4) Attach tube from PWA 26443 dispenser to lower (inlet) nozzle of mold fixture. Secure with standard hose clamp.

(5) Close or open appropriate valve(1).

(6) Open air valve(5) to actuate cylinder(6).

NOTE

Allow approximately 6 ounces of excess rubber to flow from mold overflow vent prior to capping vent (use paper cup to catch excess rubber). This will help to ensure mold is completely filled.

(7) When rubber flows from overflow outlet at top of mold, close mold fixture vent by inserting detail plug, while maintaining pressure in mold fixture for 10 seconds.

(8) Upon removal of rubber supply hose to mold, cap supply port in mold without delay to minimize reverse flow of rubber from mold.

NOTE

Some rubber leakage at various locations of mold fixtures is normal; however, such excess rubber shall be removed.

(9) Shut off air supply to dispenser. Remove tube from inlet at bottom of mold fixture. Insert plug detail into inlet.

(10) Remove and discard tube at top of mold fixture.

p. If fixtured engine part is mounted on Aronson welding positioner, rotate table detail into horizontal position.

q. Remove welding positioner strap clamps securing mold fixture. Using suitable lifting devices, lift fixtured engine part.

NOTE

Until experience is acquired on how long it takes for pre-heating of various mold fixtures, thermocouples should be attached to mold fixture to ensure 300°F (149°C) temperature has been reached prior to start of timing for cure.

r. Place fixtured engine part into curing oven (either vertical or horizontal). Cure at 290°F to 300°F (143°C to 155 °C) for 1 hour. This temperature shall be achieved at bond line for required time.

s. Using appropriate lifting devices, remove fixtured engine part from oven. Allow to cool.

CAUTION

To avoid tearing rubber, do not touch rubber when removing part from mold fixture.

t. Remove engine part from mold fixture.

CAUTION

To avoid damage to rubber, use caution when handling rubber filled parts in this semicured state. PWA 407 rubber is not cured to full strength until after final 400°F (204°C) bake cycle.

NOTE

Inspection of semicured PWA 407 rubber following initial 300°F (149°C) bake is a visual and touch to feel inspection only (durometer hardness test or bond integrity test not performed at this stage in the cure process).

u. Check rubber for lack of bond, soft spots or voids greater than 0.062 inch by the following procedures:

(1) Move fingers over entire rubber surface applying light to medium pressure. Feel for soft spots underneath surface of rubber.

(2) Visually inspect for voids or bulges in rubber surface and complete coverage of rubber to boundaries of rubber filled area on part.

(3) Using light pressure with fingers, inspect rubber for complete bonding. Use caution as rubber may be split or torn away from part if excess pressure is applied. Minor rubber tears or splits may be cemented in place using Dow Corning RTV 732 sealant (PWA 36029).

v. Repair minor defect in rubber as follows:

NOTE

- Repair of minor defects using a locally fabricated sheet metal Teflon coated plate is generally limited to areas two square inches or less.
- For defects that do not require removal of rubber to base metal, proceed to step (b).

(1) For defects which require removal of rubber to base metal proceed as follows:

(a) Remove rubber from defect area using small sharp knife.

NOTE

Defects which require rubber removal to base metal shall be cleaned and reprimed with PWA 556 primer.

(b) Remove primer using 300 grit or finer aluminum oxide paper.

(c) Wipe defect area, using clean unsized cheesecloth dampened with isopropyl alcohol. Air dry for a minimum of 15 minutes.

CAUTION

To prevent contamination of bond, avoid contact with rubber surface when applying primer to metal suraface.

(d) Apply PWA 556 primer to exposed metal. Avoid contact with rubber surface. Refer to T.O. 2-1-111.

(2) To locally fabricate sheet metal mold from 16 or 18 gage steel sheet, cut sheet 1 inch larger than damaged area. Coat sheet with Teflon S or Teflon tape on side which contacts engine part.

(3) Using spatula, or equivalent, fill damaged area with silicone rubber avoiding excess application.

(4) Apply fabricated sheet metal mold to damaged area with Teflon coated surface in contact with engine part. Secure using hand actuated toggle clamps with light to medium pressure.

(5) Place engine part into curing oven. Cure at 290° to 310°F (143° to 155°C) for 1 hour.

(6) Remove fabricated sheet metal mold.

(7) If necessary, blend repaired area using 90 grit or finer silicon carbide cloth. Wipe clean using cheesecloth.

w. Place engine part into oven without mold fixture. Cure at 390° to 410°F (198° to 210°C) for 1 hour. Remove and allow to cool.

x. Clean PWA 26443 dispenser.

y. Inspect for discoloration. Refer to applicable specific paragraph for acceptable areas of discoloration.

z. Perform hardness check. Refer to applicable specific repair paragraph for hardness limits

aa. Check integrity of rubber to metal bond. Refer to WP 101 00.

ab. Perform dimensional inspection per applicable specific repair paragraph.

ac. Machine rubber per applicable work package.

WORK PACKAGE

TECHNICAL PROCEDURES

NONDESTRUCTIVE TEST FOR RUBBER TO METAL BOND USING PWA 52879 CHECKING FIXTURE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 5	12				
6 Blank	12				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

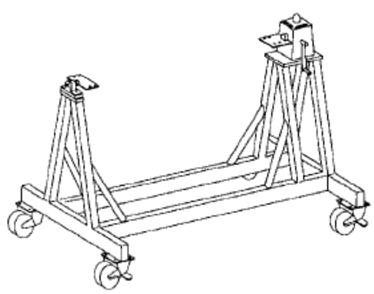
EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

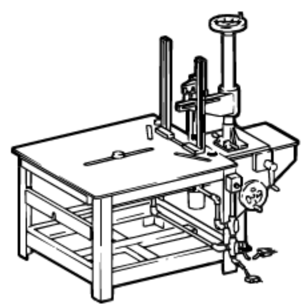
Paragraph	Function - Tool Nomenclature	Tool Number
2	Nondestructive test for rubber to metal bond using PWA 52879 checking fixture	
	Fixture, Checking - rubber bond integrity - - - - - - - - - - - - - - -	PWA 52879
	Stand - assembly and transport - - - - - -	PWA 16868

ILLUSTRATED SUPPORT EQUIPMENT



PWA 16868 –C

Figure T1. PWA 16868 Stand



PWA 52879 –C

Figure T2. PWA 52879 Fixture

1. INTRODUCTION.

a. This work package contains instructions for nondestructive test for rubber to metal bond using PWA 52879 checking fixture and PWA 16868 stand.

2. PWA 52879 CHECKING FIXTURE - NONDESTRUCTIVE TEST FOR RUBBER TO METAL BOND.

(See Figure 1.)

WARNING

Wear plastic face mask or safety glasses when operating equipment. Keep hands away from air probe at all times. Penetration of skin with needle while under pressure may prove fatal.

a. Inspect PWA 52879 fixture, detail-198, probe assembly(3) for any damage, loose pneumatic system fittings, etc. Rotate detail-205 post assembly(1) 180° away from detail-12 or -272 work surface.

b. Inspect silicone rubber on various engine parts for rubber bond integrity as follows:

(1) Set pneumatic source pressure regulator at 380 to 420 psig.

(2) Activate detail-66 solenoid valve using detail-156 foot switch to ensure line is completely pressurized and clear. Deactivate system.

(3) Install engine part on PWA 16868 stand and move part until directly under PWA 52879 fixture, detail-198, probe assembly(3). Probe assembly will enter rubber normal (perpendicular) to surface.

(4) Advance actuation head using detail-231 handwheels (clockwise is up, counterclockwise is down) until detail-169 support(4) contacts engine part.

CAUTION

Advance head slowly so as not to damage detail-198 probe assembly(3).

(5) Slowly continue advancing head assembly until detail-198 probe assembly(3) penetrates rubber and bottoms on engine part.

(6) At this point, detail-132 red indicator will begin to move, indicating metal contact.

(7) Rotate detail-231 handwheel to withdraw detail-198 probe assembly(3). Actuate detail-66 solenoid valve with detail-79 pushbutton switch and detail-156 foot switch simultaneously.

(8) If rubber is not expelled, deactivate airsource and electrical power. Raise detail-169 support(4) and visually inspect detail-198 probe assembly(3) for possible damage. Proceed with check.

(9) Deactivate system.

(10) Advance as before, and when detail-198 probe(3) bottoms out, activate detail-66 solenoid valve. This will supply 380 to 420 psig to rubber.

(11) Observe any bulging of rubber, leakage, or any pressure indication on detail-77 differential gage.

(12) Deactivate system by turning off detail-79 pushbutton and detail-156 foot switches. Loosen clamps on PWA 16868 stand and rotate (index) engine part every 6 inches. Repeat steps(5) through(8).

(13) When complete, deactivate and bleed system.

(14) If any signs of bulging or air leakage are observed, mark using china marker. Return part for correction.

NOTE

The following alternate procedure may be utilized.

c. Alternate procedure.

(1) Use a hand held needle probe assembly.

(2) Set air pressure at 380 to 420 psig.

(3) Insert needle at a 90° angle.

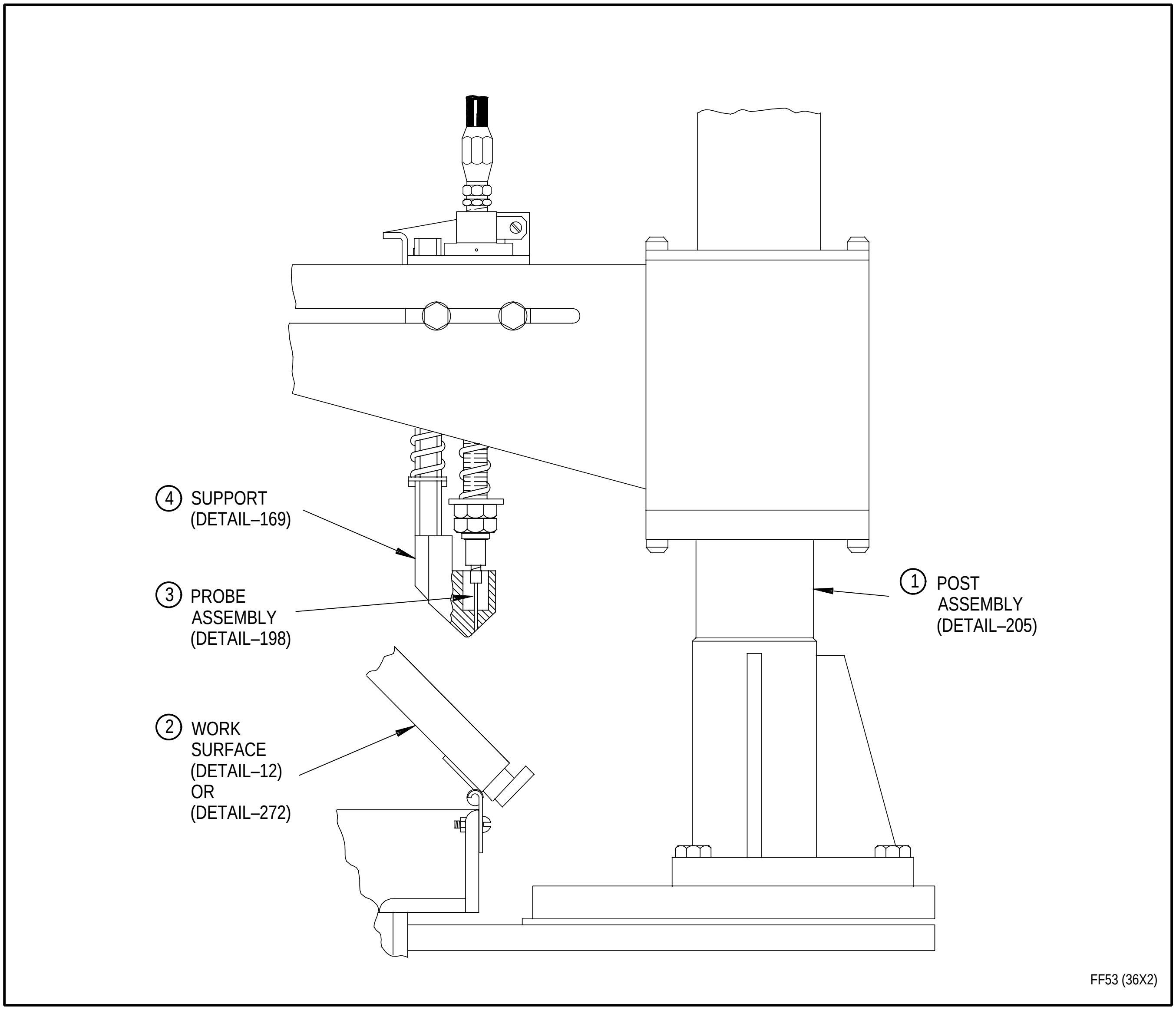


Figure 1. PWA 52879 Checking Fixture For Rubber To Metal Bond Test

WORK PACKAGE

INTRODUCTION

QUALIFIED REPAIR SOURCE LIST (QRSL)

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 2

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 2	26				

1. INTRODUCTION.

a. This work package introduces the Qualified Repair Source List (QRSL).

2. ARRANGEMENT OF QRSL.

WP No.	Title
601 00	Nonmodular Parts
602 00	Inlet/Fan Module
603 00	Core Module
604 00	Rear Compressor Drive Turbine
605 00	Fan Drive Turbine Module
606 00	Augmentor Duct and Nozzle Module
607 00	Gearbox Module
608 00	Approved Source List

3. SOURCE DEMONSTRATION REPAIRS.

a. A repair that has been identified as a Source Demonstration Repair must be performed by sources that have been approved by the USAF F100 Engineering Source Authority. To obtain a list of qualified sources or information on how to become a qualified source contact the F100 Engineering Source Authority, Kelly Air Force Base, Suite 8, 485 Quentin Roosevelt Avenue, San Antonio, Texas, 78241.

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL) NONMODULAR PARTS

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1 - 3	0				
4 Blank	0				

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package will provide the Qualified Repair Source List (QRSL) for nonmodular parts.

2. GENERAL.

(See Table 1.)

a. The QRSL has not been developed for nonmodular parts. Once developed, the QRSL data will be indexed according to Work Unit Code (WUC) and Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

WUC D/M Identi-fication	Engine Configu-ration	Part Name	Part Number	D/M Code and D/M	Vendor Name and Address	Repair Proce-dure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability

TO BE SUPPLIED

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL)

INLET/FAN MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	27	3 - 4	27	5 Added	27
2	16			6 Blank Added	27

REFERENCE MATERIAL REQUIRED

Title	Number
Inlet/Fan Module -	T.O. 2J-F100-53-6

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package provides the Qualified Repair Source List (QRSL) for the Inlet/Fan Module.

2. GENERAL.

(See Table 1.)

a. QRSL data is indexed according to Logistics Control Number (LCN) and Task Code with Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

LCN Identi- fication	Engine Configu- ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./ WP	Engine Model Appli- cability
EEA5CY-A	Inlet/ Fan Module	Bearing assembly, No. 1	4018466 4018467 4060870 4061549	JGDFGAC Outer Ring - cracks JGDFGAD Outer Ring - pits JGDFGAE Outer Ring - nicks and dents JGDFGAF Outer Ring - scratches, scuffs, and scoring JGDFGAG Outer Ring - skidding JGDFGAH Outer Ring -spalling JGDFGAJ Outer Race - axial scoring JGDFGAK Roller - pits JGDFGAL Roller - nicks and dents JGDFGAM Roller - scratches, scuffs, and scoring JGDFGAN Roller - skidding	MRC 402 Chandler St. Jamestown, NY 14701 Cage Code: 38443 FAG Bearing Corp. P.O. Box 811 Stamford, CT 06904 Cage Code: 36069 Precision Bearing Center 12 Commerce St. West Lebanon, NH 03784 Cage Code: 78118	RP237737 10/2/85 554950 3/14/89 SL 239347 Rev. D 9/13/95 435597 IC 5/98	2J-F100-53-6 Inspection WP 304 00 Repair WP 404 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./ WP	Engine Model Appli-cability
EEA5CY-A (cont.)				JGDFGAP	Roller - spalling				
				JGDFGAQ	Cage - plate flaking and peeling				
				JGDFGAR	Cage - plate wear, not in base metal				
				JGDFGAS	Cage - out of round				
				JGDFGAT	Cage - cracks				
EEA5A5	Inlet/ Fan Module	Shroud, Front Compressor Stator, Inlet	4059690	JGDFGAA	Damaged/ missing air sealing ring rubber	San Antonio - Air Logistics Center Kelley AFB San Antonio, TX	SA-ALC Process # SAP-94-036 Rev. date 11-17-94	2J-F100-53-6 Inspection WP 311 00 Repair WP 411 00	PW-229
EEA5ETAX	Inlet/ Fan Module	Seal, Air, Fan, 1st Stage	4075235 4081566	JGDFGAA	Damaged/ worn/ missing sealing ring rubber	San Antonio - Air Logistics Center Kelley AFB San Antonio, TX	SA-ALC Process # SAP-95-026	2J-F100-53-6 Inspection WP 316 00 Repair WP 416 00	PW-229
EEA5ETA1	Inlet/ Fan Module	Seal, Air, Fan, 2nd Stage	4075236	JGDFGZA	Damaged/ worn/ missing sealing ring rubber	San Antonio - Air Logistics Center Kelley AFB San Antonio, TX	SA-ALC Process # SAP-95-027	2J-F100-53-6 Inspection WP 316 00 Repair WP 416 00	PW-229
EEA5ETA3	Inlet/ Fan Module	Seal, Air, Fan, 1sst Stage	4075237	JGDFGZA	Damaged/ worn/ missing sealing ring rubber	San Antonio - Air Logistics Center Kelley AFB San Antonio, TX	SA-ALC Process # SAP-95-028	2J-F100-53-6 Inspection WP 316 00 Repair WP 416 00	PW-229

Qualified Repair Source List (QRSL) (continued) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./ WP	Engine Model Appli-cability
EEA5CY-B	Inlet/ Fan Module	Bearing assembly	4018466 4018467 4060870 4061549 4082584	JGDFGAC Outer Ring - cracks JGDFGAD Outer Ring - pits JGDFGAE Outer Ring - nicks/ dents JGDFGAF Outer Ring - scratches, scuffs, and scoring JGDFGAG Outer Ring - skidding JGDFGAH Outer Ring -spalling JGDFGAJ Outer Race - axial scoring JGDFGAK Roller - pits JGDFGAL Roller - nicks/ dents JGDFGAM Roller - scratches, scuffs, and scoring JGDFGAN Roller - skidding JGDFGAP Roller - spalling JGDFGAQ Cage - Plate flaking/ peeling JGDFGAR Cage - plate wear, not in base metal JGDFGAS Outer Ring - Out of round JGDFGAT Outer Ring - Cracks	FAG Bearings Ltd. AC/SP Division P.O. Box 640 801 Ontario St. Stratford, Ontario, Canada N5A6T2	592792 Rev. D. 3/5/98	2J-F100-53-6 Inspection WP 304 00 Repair WP 404 00	PW-229

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL)

CORE ENGINE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 10

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	29	4	26	5	29
2	15	4A Added	29	6 - 7	27
3	20	4B Blank Added	29	8 Added	27

REFERENCE MATERIAL REQUIRED

TITLE	NUMBER
Core Engine Module	T.O. 2J-F100-53-7

Additional required reference material can be found in applicable tables.

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package provides the Qualified Repair Source List (QRSL) for the Core Engine Module.

2. GENERAL.
(See Table 1.)

a. QRSL data is indexed according to Logistics Control Number(LCN) and Task Code with Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

LCN Identi-fication	Engine Configuration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBAAAA	Core Engine Module	No. 2 Bearing Face Seal Assembly	4033283 4033284 4072837 4072839	JGDFGAC Carbon Element Replace-ment	EG&G Sealol, Inc. 15 Pioneer Ave. Warwick, RI 02888 Cage Code #04738	SC40143 SC40144 SC42692	2J-F100-53-7 Inspection WP 317 00 Repair WP 417 00	PW-229
					Kayden Ring & Seal, Inc. 1600 Wicomico St. Baltimore, MD 21230 Cage Code #75370	Kayden PN102736 PN102737 PN101561 PN102021		
					Praxair Surface Tecnologies, Inc. 1234 Atlantic St. N. Kansas City, MO 64116 Cage Code #4L225	JI #000272		
EEBBB5AAA	Core Engine Module	4th Stage Compressor Blade	4081604	JGDFGZB CBN Coated Blade Tip Wear	Pratt & Whitney PW-ORO 400 Main Street E.H., CT. 06108 Well 14 Cage Code: 77445	Operation Sheet 4081604 Rev 0 07/22/96	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AC	Core Engine Module	5th Stage Compressor Blade	4081605	JGDFGZD CBN Coated Blade Tip Wear	Pratt & Whitney PW-ORO 400 Main Street E.H., CT. 06108 Well 14 Cage Code: 77445	Operation Sheet 4081605 Rev 0 07/22/96	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBB5AE	Core Engine Module	6th Stage Compressor Blade	4081506	JGDFGZD CBN Coated Blade Tip Wear	Pratt & Whitney PW-ORO 400 Main Street E.H., CT. 06108 Well 14 Cage Code: 77445	Operation Sheet 4081506 Rev 0 07/22/96	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AG	Core Engine Module	7th Stage Compressor Blade	4081507	JGDFGZD CBN Coated Blade Tip Wear	Pratt & Whitney PW-ORO 400 Main Street E.H., CT. 06108 Well 14 Cage Code: 77445	Operation Sheet 4081507 Rev 0 07/22/96	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AJ	Core Engine Module	Blade - Compr., Rotor, 8th Stage	4075608 4079308 4082208	JGDFGZB Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES Well 14 400 Main Street. E.Hartford, Ct 06108 Cage Code #8N802	Operation Sheet 4082208 Rev 12 9/29/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AM	Core Engine Module	Blade - Compr., Rotor, 9th Stage	4075609 4079309 4081609	JGDFGZB Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES Well 14 400 Main Street. E.Hartford, Ct 06108 Cage Code #8N802	Operation Sheet 4081609 Rev 04 10/20/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AP	Core Engine Module	Blade - Compr., Rotor, 10th Stage	4075610 4079310 4082210	JGDFGZA Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES Well 14 400 Main Street E.Hartford, Ct 06108 Cage Code #8N802	Operation Sheet 4082210 Rev 03 10/20/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBB5AR	Core Engine Module	Blade - Compr., Rotor, 11th Stage	4075611 4079411 4081611	JGDFGZA Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES, Well 14, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	Operation Sheet 4081611 Rev 01 10/07/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AT	Core Engine Module	Blade - Compr., Rotor, 12th Stage	4075612 4079412 4082212	JGDFGZA Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES, Well 14, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	Operation Sheet 4082212 Rev 04 09/30/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AV	Core Engine Module	Blade - Compr., Rotor, 13th Stage	4075613 4079413 4081613	JGDFGZA Blade tip coating wear, strip and recoat with CBN	Pratt & Whitney PWES, Well 14, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	Operation Sheet 4081613 Rev 01 10/07/97	2J-F100-53-7 Inspection WP 374 00 Repair WP 474 00	PW-229
EEBBB5AZ	Core Engine Module	Disk and Hub, Compr., 6th Stage	4070836	JGDFGZC Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	O/S 4070846 05/22/97	2J-F100-53-7 Inspection WP 305 00 Repair WP 405 00	PW-229
EEBBB5A1	Core Engine Module	Disk - Drum Rotor, Rear, Compr., Rear	4073123 4080102	JGDFGZD Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	O/S 4073123 05/22/97	2J-F100-53-7 Inspection WP 361 00 Repair WP 461 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBB5A2	Core Engine Module	Seal-Air, No. 4 Bearing, Front	4080806	JGDFGZC Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	ORO-4080806 08/01/97	2J-F100-53-7 Inspection WP 334 00 Repair WP 438 00	PW-229
EEBBB5NG	Core Engine Module	Disk-Drum Rotor, Rear Compr., Front	4074700 4080396 4080408	JGDFGZB Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E.Hartford, CT 06108 Cage Code #8N802	ORO-4080396 08/11/97	2J-F100-53-7 Inspection WP 302 00 Repair WP 402 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBB8	Core Engine Module	Ring, Airseal, Turb, 1st Stage	4080430-01	JGDFGZD	Pratt & Whitney-Overhaul and Repair Operations 400 Main St. E.Hartford, CT 06108 Cage Code #8N802	18998 Rev. 7 1/22/97	2J-F100-53-7 Inspection WP 359 00 Repair WP 459 00	PW-229
EEBBFU	Core Engine Module	No. 4 Bearing	4059297 4059298 4059299 4061007	JGDFG Outer Ring AA Hardness Unacceptable AB Heat Discoloration AC Galling AD Brinelling AE Cracks AF Pits AG Nicks, Dents AH Scratches, Scuffing, Scoring AJ Skidding AK Spalling Ring AL Heat Discoloration Roller AM Galling AN Heat Discoloration AP Brinelling AQ Pits AR Nicks, Dents(over limits) AS Scratches, Scuffing, Scoring AT Skidding AU Spalling AV End Wear Cage AX Plate Flaking and Peeling AY Plate Wear, not in Base Metal AZ Out of Round BA Cracks BB Pits, not in Base Metal BC Nicks, Dents	FAG Bearing Corp. P.O. Box 811, 118 Hamilton Ave. Stanford, CT 06904 Cage Code: 43991 MRC 402 Chandler Street, Jamestown, NY 14701 Cage Code: 38443 Precision Bearing Center 12 Commerce Ave. W. Lebanon, NH 03784 Cage Code: 78118 FAG Bearings Ltd. AC/SP Division P.O. Box 640, 801 Ontario St. Stratford, Ontario, Canada N5A 6T2	553064B 3/26/98 RP236750 6/26/85 SL239326 Revd. 9/18/95 553064B 3/26/98	2J-F100-53-7 Inspection WP 339 00 Repair WP 439 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-ficationz	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBFU-1	Core Engine Module	No. 4 Bearing	4059297 4059298 4059299 4061007	JGDFG Inner Race AW ID Wear	FAG Bearing Corp. P.O. Box 811, 118 Hamilton Ave. Stanford, CT 06904 Cage Code: 43991 Precision Bearing Center 12 Commerce Ave. W. Lebanon, NH 03784 Cage Code: 78118	IR553064 B-DA1.00 2/93 SL239326 Rev. D 9/18/95	2J-F100-53-7 Inspection P 339 00 Repair WP 439 00	PW-229
EEBBMD	Core Engine Module	Ring, Airseal, Turb, Inner, 1st Stage	4070980-01	JGDFGZC	Pratt & Whitney - Overhaul and Repair Operations 400 Main Street E. Hartford, Ct 06108 Cage Code: 8N802	19010 Rev. 6 1/22/97	2J-F100-53-7 Inspection WP 359 00 Repair WP 459 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi- fication	Engine Configu- ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli- cability
EEBBAEAD	Core Engine Module	No. 2 Bearing	4075346 4075347 4075348 4081019 4081020 4081023	JGDFG Cage AA Plate Flake/ Peel AB Plate Wear AC Out of Round AD Crack Ring AE Galling AF Brinelling AG Pit AH Dent/Nick AJ Scratches, Scuffs, Scoring AK Skidding AL Spalling Ball AM Heat Discolor AN Brinelling AP Pits AQ Nick/Dent AR Scratches, Scuffs, Scoring AS Skidding	Precision Bearing Center, 12 Commerce Ave. West Lebanon, NH 03784 Cage Code: 78118 FAG Bearings Ltd. AC/SP Division P.O. Box 640 801 Ontario St. Stratford, Ontario, Canada N5A6T2	4075349IC Rev. Date: 5/6/98 4081024IC Rev. Date 5/6/98 590318B Rev. Date: 5/4/98	2J-F100-53-7 Inspection WP 339 00 Repair WP 439 00	PW-229
EEBBAP	Core Engine Module	No. 3 Bearing	4075315 4075317 4078319	JGDFG Cage AA Plate Flake/ Peel AB Plate Wear AC Out of Round AD Crack Ring AE Galling AF Brinelling AG Pit AH Dent/Nick AJ Scratches, Scuffs, Scoring AK Skidding AL Spalling Ball AM Heat Discolor AN Brinelling AP Pits AQ Nick/Dent AR Scratches, Scuffs, Scoring AS Skidding	Precision Bearing Center, 12 Commerce Ave. West Lebanon, NH 03784 Cage Code: 78118 FAG Bearings Ltd. AC/SP Division P.O. Box 640 801 Ontario St. Stratford, Ontario, Canada N5A6T2	4075314IC Rev. Date: 5/6/98 590803 Rev. Date 5/4/98	2J-F100-53-7 Inspection WP 339 00 Repair WP 439 00	PW-229

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL)

REAR COMPRESSOR DRIVE TURBINE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 4

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	29	2	21	3 - 4	29

REFERENCE MATERIAL REQUIRED

Title	Number
Depot Fan Drive Turbine Module	T.O. 2J-F100-53-9

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package provides the Qualified Repair Source List (QRSL) for the Rear Compressor Drive Turbine.

2. GENERAL.

(See Table 1.)

a. QRSL data is indexed according to Logistics Control Number (LCN) and Task Code with Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEBBCCAA	Rear Compr., Drive Turb. Module	Hub, Turbine, Front	4069333	JGDFGZB	Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4068689 08/01/97	2J-F100-53-8 Inspection WP 314 00 Repair WP 414 00	PW-229
EEBBCCAM	Rear Compr., Drive Turb. Module	Seal, Air, Turb., 1st Stage	4069949 4080429 4083238 4083562	JGDFGZB	Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4069949 09/02/97	2J-F100-53-8 Inspection WP 301 00 Repair WP 401 00	PW-229
EEBBCCAP	Rear Compr., Drive Turb. Module	Plate, Retg., Blade, Turb., 1st Stage	4069990	JGDFGZB	Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4069990 08/01/97	2J-F100-53-8 Inspection WP 302 00 Repair WP 402 00	PW-229
EEBBCCAJ	Rear Compr. Drive Turb. Module	Plate, Retg., Blade, Turb., 2nd Stage	4070147	JGDFGZD	Worn Knife Edge Coating	Pratt & Whitney Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4069989 08/04/97	2J-F100-53-8 Inspection WP 309 00 Repair WP 409 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EECFBPAC	Fan Drive Turbine Module	Case - Turbine Rear, Assembly of	4079211 4079212	JGDFGAM	Aft end damage	Pratt & Whitney PSD Inc., P.O. Box 1220 Springdale, AR 72765-1220 Cage Code: C0019	9756-000 7/22/96	2J-F100-53-9 Inspection WP 304 00 Repair WP 404 00	PW-229
				JGDFGAN	Dia. ’AM’ damage		9757-000 7/22/96		
				JGDFGAP	Dia. ’AS’ damage		9758-000 7/24/96		
				JGDFGAQ	Dia. ’B’ damage		9761-000 7/26/96		
				JGDFGAR	Dia. ’G’ damage				
				JGDFGAS	Dia. ’J’ damage				
				JGDFGAT	Flg. ’AA’ damage				
				JGDFGAU	Flg. ’AC’ damage				
				JGDFGAV	Flg. ’AD’ lug/standup damage				
				JGDFGAW	Flg. ’AE’ damage				
				JGDFGAX	Flg. ’AH’ lug/standup damage				
				JGDFGAY	Instru-ment-ation boss crack				

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL) FAN DRIVE TURBINE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	29	3	29	5 Added	27
2	0	4	27	6 Blank Added	27

REFERENCE MATERIAL REQUIRED

Title	Number
Depot Fan Drive Turbine Module - - - - - - - - - - - - - - - - - - -	T.O. 2J-F100-53-9

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package provides the Qualified Repair Source List (QRSL) for the Fan Drive Turbine Module.

2. GENERAL.

(See Table 1.)

a. QRSL data is indexed according to Logistics Control Number (LCN) and Task Code with Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

LCN Identi- fication	Engine Configu- ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address, and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli- cability
EECFBPAA	Fan Drive Turbine Module	Seal, Air, Turbine, 3rd Stage	4071396 4083240	JGDFGZB Worn Knife Edge Coating	Pratt & Whitney - Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4083240 08/01/97	2J-F100-53-9 Inspection WP 310 00 Repair WP 410 00	PW-229
EECFBPBJ	Fan Drive Turbine Module	Seal, Air, Turbine, 4th Stage	4073146 4081755	JGDFGZB Worn Knife Edge Coating	Pratt & Whitney - Eagle Services, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	ORO-4081755 08/01/97	2J-F100-53-9 Inspection WP 320 00 Repair WP 410 00	PW-229
EECFBPBM	Fan Drive Turbine	3rd Stg Turbine ID Airseal Ring	4064232	JGDFGZC	Pratt & Whitney - Overhaul & Repair Operations, 400 Main St., E. Hartford, CT 06108 Cage Code: 8N802	4064232 10/31/95 Revision 2	2J-F100-53-9 Inspection WP 308 00 Repair WP 408 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EECFAJ-A	Fan Drive Turbine Module	No. 5 Bearing	4067893 4067894 4067895	JGDFG Rings AA Heat Discolorization AB Galling AC Brinelling AD Cracks AE Pits AF Dent/Nick AG Scratches, Scuffs, Scoring AH Skidding AJ Spalling Roller AK Galling AL Heat Discolorization AM Brinelling AN Pits AP Dent/Nick AQ Scratches, Scuffs, Scoring AR Skidding AS Spalling AT End Wear Cage AU Plate Flake/Peel AV Plate Wear AW Out of Wear AX Crack Rings AY O. Race Scoring	Precision Bearing Center, 12 Commerce Ave. West Lebanon, NH 03784 Cage Code: 78118	SL 241591 N/C 2/1/96	2J-F100-53-9 Inspection WP 332 00 Repair WP 425 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EECFAJ-B	Fan Drive Turbine Module	No. 5 Bearing	4067893 4067894 4067895 4082552	JGDFG Rings AA Heat Discolorization AB Galling AC Brinelling AD Cracks AE Pits AF Dent/Nick AG Scratches, Scuffs, Scoring AH Skidding AJ Spalling Roller AK Galling AL Heat Discolorization AM Brinelling AN Pits AP Dent/Nick AQ Scratches, Scuffs, Scoring AR Skidding AS Spalling AT End Wear Cage AU Plate Flake/Peel AV Plate Wear AW Out of Wear AX Crack Rings AY O. Race Scoring	FAG Bearings Ltd. AC/SP Division P.O. Box 640 801 Ontario St. Stratford, Ontario, Canada N5A6T2	592793 Rev. D 5/4/98	2J-F100-53-9 Inspection WP 332 00 Repair WP 425 00	PW-229

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL)

AUGMENTOR DUCT AND NOZZLE MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 8

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	29	2B Blank Added	29	4	19
2	8	3	29	5	26
2A Added	29			6 Blank Added	19

REFERENCE MATERIAL REQUIRED

Title	Number
Augmentor Duct and Nozzle Module - - - - - - - - - - - - - - - - - - -	T.O. 2J-F100-53-10

Additional required reference material can be found in applicable tables.

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package provides the Qualified Repair Source List (QRSL) for the Augmentor Duct and Nozzle Module.

2. GENERAL.

(See Table 1.)

a. QRSL data is indexed according to Logistics Control Number (LCN) and Task Code with Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./ WP	Engine Model Appli-cability
EEFFAAAA	Augmentor/ Nozzle	Nozzle Segment, Cast Balance	4070067	JGDFGAG JGDFGAH JGDFGAJ JGDFGAK JGDFGZB	Cast post wear Hinge hole elongation Locking feature tang damage Cracks on segment side Hinge wear	AAR Engine Component Services, One West Frankfort Industrial Park Drive, Frankfort, NY 13340 Cage Code: 44639 Gunver Manufacturing Co., Inc. 255 Sheldon Rd. Manchester, CT 06040 Cage Code: 59420	F-15550 11/26/97 GPR-306 08/24/98	2J-F100-53-10 Inspection WP 315 00 Repair WP 415 00	PW-229
EEFFAAAD	Augmentor/ Nozzle	Nozzle Segment, Convergent	4070742	JGDFGAC JGDFGZA JGDFGZE JGDFGZF	Hinge wear Elongated fwd hinge holes Guide post wear Elongated aft hinge holes	Gunver Manufacturing Co., Inc. 255 Sheldon Rd. Manchester, CT 06040 Cage Code: 59420	GPR-307 08/24/98	2J-F100-53-10 Inspection WP 310 00 Repair WP 410 00	PW-229

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi- fication	Engine Configu- ration	Part Name	Part Number	Task Code and D/M	Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli- cability
EEFFAABV	Augmentor Duct and Nozzle Module	Augmentor Convergent Nozzle Segment Liner Assembly	4070107	JGDFGAC Silicide coating chipped JGDFGAD Aft end erosion JGDFGAF Forward end wear JGDFGAG Hardface coating missing JGDFGAH Curled edge erosion/ missing material	Associated Aerospace Activities, Inc., 2502 Williams St., San Leandro, CA 94577-3194 Cage Code: #51226	AAAI Process #43 6/25/93	2J-F100-53-10 Inspection WP 313 00 Repair WP 413 00	PW-229
EEFFAABV-1	Augmentor Duct and Nozzle Module	Augmentor Convergent Nozzle Segment Liner Assembly	4070107	JGDFGAC Silicide coating chipped JGDFGAD Aft end erosion JGDFGAF Forward end wear JGDFGAG Hardface coating missing JGDFGAH Curled edge erosion/ missing material	Gunver Manufacturing Co., Inc., 255 Sheldon Rd., Manchester, CT 06040 Cage Code: #59420	Gunver Process GPR-300 4/24/96	2J-F100-53-10 Inspection WP 313 00 Repair WP 413 00	PW-229
				JGDFGAJ Rivet hole elongation JGDFGAK Holes worn from finger seal contact JGDFGAL Curled edge burn-through JGDFGAM Facesheet cracks and thermal erosion JGDFGAN Curled edge and trailing edge warpage	Precision Southwest Manufacturing, Inc., 3755 N. Romero Rd., Tucson, AZ 85705 Cage Code: 06SM7	PSM Process #0107 6/27/95		

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi- fication	Engine Configu- ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli- cability
EEFFAACD	Augmentor Duct and Nozzle Module	Augmentor Convergent Nozzle Segment Seal Assembly	4078304	JGDFGAA	Facesheet cracks or missing material	Gunver Manufacturing Co., Inc. 255 Sheldon Rd. Manchester, CT 06040 Cage Code: 59420	Gunver Process GPR-303 4/24/96	2J-F100-53-10 Inspection WP 308 00 Repair WP 408 00	PW-229
				JGDFGAB	Facesheet finger seal hardface coating missing				
				JGDFGAD	Facesheet rivet hole elongation				
				JGDFGAE	Hardface coating wear or missing at interface	Precision Southwest Manufacturing, Inc. 3755 N. Romero Rd. Tucson, AZ 85705 Cage Code: 06SM7	PSM 8304 2/2/96		
				JGDFGAF	Bolt anchor damaged/ stripped, replace.				
				JGDFGAG	Backsheet brace cracks				
EEFFAACD - 1	Augmentor Duct and Nozzle Module	Augmentor Convergent Nozzle Segment Seal Assembly	4071130	JGDFGAA	Facesheet cracks or missing material	Gunver Manufacturing Co., Inc. 255 Sheldon Rd. Manchester, CT 06040 Cage Code: 59420	Gunver Process GPR-302 4/24/96	2J-F100-53-10 Inspection WP 308 00 Repair WP 408 00	PW-229
				JGDFGAB	Facesheet finger seal hardface coating missing				
				JGDFGAD	Facesheet rivet hole elongation				
				JGDFGAE	Hardface coating wear or missing at interface	Precision Southwest Manufacturing, Inc. 3755 N. Romero Rd. Tucson, AZ 85705 Cage Code: 06SM7	PSM 1130 2/2/96		
				JGDFGAF	Bolt anchor damaged/ stripped, replace.				
				JGDFGAG	Backsheet brace cracks				

Table 1. Qualified Repair Source List (QRSL) (continued)

LCN Identi-fication	Engine Configu-ration	Part Name	Part Number	Task Code and D/M		Vendor Name, Address and Cage Code	Repair Procedure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability
EEFFAACG	Augmentor Duct and Nozzle Module	Augmentor Divergent Nozzle Segment Seal Assembly	4076459	JGDFGAJ	Non-gaspath Zone A cracks	AAR Engine Component Services, One West Frankfort Industrial Park Drive, Frankfort, New York 13340	P676 Revision C 8/17/93	2J-F100-53-10 Inspection WP 305 00 Repair WP 405 00	PW-229
				JGDFGAK	Non-gaspath Zone B cracks				
				JGDFGAE	Gaspath facesheet cracks				
				JGDFGAL	Seal stiffener cracks				
EEFFAACG	Augmentor Duct and Nozzle Module	Augmentor Divergent Nozzle Segment Seal Assembly	4076459 4072683	JGDFGAJ	Non-gaspath Zone A cracks	Gunver Manufacturing Company, Inc. 151 Sheldon Rd. Manchester, CT 06040 Cage Code:59420	Gunver Process GPR-304 11/25/97	2J-F100-53-10 Inspection WP 305 00 Repair WP 405 00	PW-229
				JGDFGAK	Non-gaspath Zone B cracks				
				JGDFGAE	Gaspath facesheet cracks				
				JGDFGAL	Seal stiffener cracks				

WORK PACKAGE

TECHNICAL PROCEDURES

QUALIFIED REPAIR SOURCE LIST (QRSL) GEARBOX MODULE

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 4

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package will provide the Qualified Repair Source List (QRSL) for the Gearbox Module.

2. GENERAL.

(See Table 1.)

a. The QRSL has not been developed for the Gearbox Module. Once developed, the QRSL data will be indexed according to Work Unit Code (WUC) and Distress Mode (D/M).

Table 1. Qualified Repair Source List (QRSL)

WUC D/M Identi-fication	Engine Configu-ration	Part Name	Part Number	D/M Code and D/M	Vendor Name and Address	Repair Proce-dure and Date	Inspection and Repair T.O./WP	Engine Model Appli-cability

TO BE SUPPLIED

WORK PACKAGE

TECHNICAL PROCEDURES

APPROVED SOURCE LIST

EFFECTIVITY: ENGINE MODEL F100-PW-229

LIST OF EFFECTIVE WP PAGES

Total Number of Pages in this WP is 6

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
1	28	2	11	3 - 6	28

REFERENCE MATERIAL REQUIRED

None

APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

None

CONSUMABLE MATERIALS

None

EXPENDABLE ITEMS

None

APPLICABLE SUPPORT EQUIPMENT

None

ILLUSTRATED SUPPORT EQUIPMENT

None

1. INTRODUCTION.

a. This work package contains various processes Approved Source Lists used in WP/SWP throughout this manual set.

b. Process descriptions are provided with qualified sources, reference T.O. locations, source symbols, procedure numbers and dates, engine applications, and appropriate remarks.

c. This work package contains various tables of Approved Source Lists with Qualified Sources for:

- Water Jet Cleaning of First Stage Turbine Blades and Vanes.
- Application of Silicide Coating (PWA 295).
- Ultra-High Pressure Water Jet Stripping of Abradable Seal

2. GENERAL.

a. Table 1 lists qualified sources alphabetically with addresses.

b. Table 2 lists process descriptions, engine application, appropriate remarks, and appropriate table within this WP where qualified sources are listed.

c. Remaining tables list qualified sources, reference T.O. locations, source symbols, procedure numbers and dates, engine applications, and appropriate remarks.

d. The use of alternate sources shall be at the operator’s discretion and responsibility.

Table 1. Qualified Source Address List

Qualified Source	Address	Qualified Source	Address
USAF - San Antonio Air Logistics Center (SA-ALC)	Kelly Air Force Base San Antonio, Texas 78241	Vac-Hyd 3B464	515 W.Apra Street Compton, Ca 90220
		Hitemco 9Z923	160 Sweet Hollow Road Old Bethpage, NY 11804

Table 2. Process Descriptions to WP 608 00 Tables Cross-Reference List

Process Description	Engine Application	Remarks	WP 608 00 Table
Water Jet Cleaning of 1st Stage Turbine Blades and Vanes	PW-229	For removal of volcanic ash deposits from airfoil surfaces and cooling holes.	Table 3
Application of Silicide Coating (PWA 295)	PW-229	Augmentor convergent nozzle segment liner and augmentor convergent nozzle segment seal liner	Table 4
Ultra-High Pressure Water Jet Stripping	PW-229	Abradable Seal Removal	Table 5

Table 3. Approved Source List - Water Jet Cleaning of HPT Airfoils

Qualified Source	Process Description	T.O. Location	Source Symbol	Procedure No.and Date	Engine Application	Remarks
SA-ALC	Water Jet Cleaning for Removal of Volcanic Ash	2J-F100-53-8, WP 202 00	N/A	SAP	PW-229	1st stage turbine blade
		2J-F100-53-7, WP 202 00	N/A	SAP	PW-229	1st stage turbine vane

Table 4. Approved Source List - Silicide Coating (PWA 295)

Qualified Source	Process Description	T.O. Location	Source Symbol	Procedure No. and Date	Engine Application	Remarks
Vac-Hyd 3B464	Silicide Coating Application (PWA 295)	2J-F100-53-10, WP 408 00 WP 413 00	☼	PWA F100 2/21/95	PW-229	Augmentor Convergent Nozzle Segment Seal Liner Augmentor Convergent Nozzle Segment Liner
Himetco 9Z923	Silicide Coating Application (PWA 295)	2J-F100-53-10, WP 408 00 WP 413 00	ⓗ	PCD 2500 Rev J 4/7/94	PW-229	Augmentor Convergent Nozzle Segment Seal Liner Augmentor Convergent Nozzle Segment Liner

Table 5. Approved Source List - Ultra-High Pressure Water Jet Stripping

Qualified Source	Process Description	T.O. Location	Source Symbol	Procedure No. and Date	Engine Application	Remarks
USAF-San Antonio Air Logistics Center (SA-ALC)	Ultra-High Pressure Water Jet Stripping of PWA 407 Rubber Air Seal	2J-F100-53-6, WP 418 00	N/A	SAP TN005G	PW-229	1st Stage Compressor Stator
		2J-F100-53-6, WP 418 00		SAP TN006G		2nd Stage Compressor Stator